Chapter 6.0 Effects of the Proposed Action

6.1 Introduction

"Effects of the action" refers to the direct and indirect effects of a proposed action on listed species or critical habitat, together with the effects of other activities that are interrelated to or interdependent with that action.

In accordance with the provisions of the ESA implementing regulations and the USFWS Section 7 Handbook, Reclamation uses the following definitions to make its effects determinations for each listed species:

May Affect - Likely to adversely affect (MA/LAA): Any adverse effect to ESA-listed species or their critical habitat may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (see definition of is not likely to adversely affect). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action is likely to adversely affect the listed species. If incidental take is anticipated to occur as a result of the proposed action, and is likely to adversely affect determination should be made.

May Affect - Not likely to adversely affect (MA/NLAA): Effects on ESA-listed species or their critical habitat are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

No effect (NE): When the action agency determines its proposed action will not affect listed species or critical habitat.

6.2 SONCC Coho Salmon

This section describes the effects of the proposed action on SONCC coho salmon inhabiting the Rogue River basin and the mainstem Klamath River downstream from Iron Gate Dam. Hydrology and habitat approaches are used to analyze effects.

6.2.1 Rogue River Basin

Analysis Approach

The lack of hydrology data and existing fish flow needs data limit the Rogue River basin hydrology analysis mainly to a qualitative discussion of effects on coho salmon in the Rogue River basin. Streamflow data collection has been inconsistent over the years and records are incomplete. Many stream gages haven't operated for extended periods of time. The Facilities and Operations report (Vinsonhaler 2002) discusses periods of no data collection. This section describes the approach for identifying effects of operations on SONCC coho salmon inhabiting Little Butte Creek and Bear Creek watersheds.

The Rogue River basin, the Little Butte and Bear Creek Surface Water Distribution Model, DRAFT Model Version March 26, 2003 (Reclamation 2003) was used to simulate "without Reclamation" and "with Reclamation" stream flows. Psces was developed by Reclamation's Pacific Northwest Regional Office for viewing and portraying data. A CD copy of Pisces and the associated database can be found in Appendix B. "With Reclamation" monthly exceedance flows were modeled at various locations in Little Butte Creek and Bear Creek drainages and compared to "without Reclamation" flows to determine the effects of the proposed action. An exceedance flow is the flow that is equaled or exceeded a certain percentage of the time. Flows at the 10 percent level can be interpreted as high flows; 50 percent level flows are median flows; and 90 percent level flows are low flows. Flow effects due to the "with Reclamation", as a percentage of the "without Reclamation," were considered minor if less than or equal to 10 percent, moderate from 11-20 percent; and major if greater than 20 percent. The rational for these percentages is similar to that used by NMFS (2002). Where possible, "with Reclamation" and "without Reclamation" flows were compared to seasonal OWRD instream flow water rights (Tables 4-3 and 4-6) at the 50 percent exceedance level to assess potential impacts on coho salmon.

Effects on Fry, Juvenile, and Smolt Life Stages from February through June

The requirements of fry, juvenile, and smolt coho salmon during this time period include shallow gravel areas, rearing habitat consisting of a mixture of pools and riffles, instream and bank cover, and low amount of fine sediments.

During this time period, Reclamation is diverting water through Dead Indian and South Fork Little Butte Collection Canals for storage in Howard Prairie Lake and storing natural flow water in Emigrant Lake. Some release of natural and stored flows may begin in June in the Bear Creek system.

South Fork Little Butte Creek and Tributary Streamflows

Aquatic habitat conditions in South Fork Little Butte Creek affected (directly and indirectly) by operations are streamflow, water quality, and fish passage.

South Fork Little Butte Creek is impaired from a flow modification standard because irrigation water withdrawal causes low streamflows. However, several tributaries to this stream increases natural streamflow and provides improved spawning and rearing conditions for coho salmon and steelhead. Coho salmon and steelhead spawn throughout this stream and its tributaries in most years. Coho salmon fry habitat becomes increasingly important in the spring as irrigation depletions within tributaries begin to limit available salmon fry habitat in those tributaries, especially in drier years. Also, coho salmon fry must compete with other species for available habitat in the spring. Out-migrating coho salmon smolts must use the tributaries as they travel to the sea. Juvenile coho salmon from the previous year's cohort transform to the smolt life stage and migrate toward the sea during the spring. The size of the fish, flow conditions, water temperature, dissolved oxygen levels, day length, and the availability of food all tend to affect the time of migration (Sandercock 1991).

Table 5-7 compares "without Reclamation" and "with Reclamation" monthly flows for South Fork Little Butte Creek flows near Lake Creek.

In the February to June time period, "with Reclamation" results in major flow decreases at exceedance levels equal to or greater than 50 percent (average and dry water years) in February, March, April and May. The only major flow change occurs in June at the 10 percent exceedance (greater than average water year) level (39 cfs decrease). This may result in decreased availability of resources for fry and juvenile coho salmon in South Fork Little Butte Creek, particularly during average and dry water years. Coho salmon fry and juveniles may be affected by major flow decreases resulting from "with Reclamation" by decreased carrying capacity and displacement into less suitable habitat. As a result, survival of young coho salmon may be affected in drier water years. However, it should be noted that average “with Reclamation” and “without Reclamation” flows would exceed OWRD instream flow water rights in South Fork Little Butte Creek at the mouth in March, April, and May. Both modeled scenarios would be less than the instream flow reservation in June. In February, only “with Reclamation” flows at the 50 percent exceedance level (104 cfs) would be less than the flow reservation of 120 cfs. Although there are no empirical data demonstrating a clear association between a reduction in Rogue River basin tributary flows and the recruitment and survival of coho salmon, this issue has been studied extensively (NMFS 2002). Several studies, Cada et al. (1994), Giorgi (1993), and Berggren and Filardo (1993), in other geographic areas generally supported the premise that increased flow led to increased smolt survival.

Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages or critical habitat for coho salmon in South Fork Little Butte Creek.

Little Butte Creek

Table 5-7 compares “without Reclamation” and “with Reclamation” monthly flows in Little Butte Creek at Lake Creek.

Under present habitat conditions, Little Butte Creek provides an important seasonal migration corridor for upstream and downstream migrating salmon and steelhead. In general, “with Reclamation” flows are slightly less than “without Reclamation” flows. The only major flow effects occur in May and June. In May, “with Reclamation” flows are 50 cfs in a dry year compared to 65 cfs under “without Reclamation” conditions; a reduction of 15 cfs or a 23 percent reduction. In June, “with Reclamation” flows are 111 and 37 cfs in wet and average water years, respectively. This compares with “without Reclamation” flows of 87 and 24 cfs, or 28 percent and 54 percent flow increases.

At least 24 cfs must be passed to meet downstream senior water rights in Little Butte Creek when Federal and non-Federal facilities are diverting from North Fork and South Fork Little Butte Creek. North Fork and lower South Fork Little Butte Creek Diversion Dams share in passing this water to provide some flow in both streams downstream from the diversion dams (Bradford 2001). The ODFW’s Little Butte Creek instream flow right (100 cfs) has priority prior to April 1 and is always met by the “with Reclamation”. The 100 cfs instream flow water right is also met in April and the 60 cfs water right is met in May at the 50 percent exceedance level. Both modeled scenarios are less than the 60 cfs water right in June at the 50 percent exceedance level.

Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages (during peak downstream migration in May) or critical habitat for coho salmon in mainstem Little Butte Creek.

Antelope Creek

Antelope Creek merges with Little Butte Creek at RM 3.2 downstream from the city of Eagle Point. Most water at Antelope Creek Diversion Dam is diverted in the winter and spring. Hydrology in this stream was not modeled. In the February – June time period, OWRD instream flow water rights for Antelope Creek at the mouth are 25 cfs (February-April), 10 cfs (May), and 5 cfs (June). Operations that result in average monthly flows less than these levels may affect coho fry, juvenile, and smolt life stages.

Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages or critical habitat for coho salmon in Antelope Creek.

Emigrant Lake and Emigrant Creek

No ramping rate protocols are required during changes in Emigrant Lake releases. Rapid down ramping may strand small fish and other aquatic organisms in isolated pools. However, a private dam located about one-half mile downstream from Emigrant Dam on Emigrant Creek is a blockage to upstream salmon migration.

Table 5-5 compares “without Reclamation” and “with Reclamation” monthly flows in Emigrant Creek below Emigrant Dam.

From February through June, “with Reclamation” flows are always less than “without Reclamation” flows in this reach. The greatest flow reductions occur in February and March ranging from a reduction of 111 cfs or a 46 percent decrease in a wet March (10 percent exceedance) to a reduction of 7 cfs or a 100 percent decrease in a dry February and March (90 percent exceedence). During drier years, no flow is present with the “with Reclamation” from February through May. This compares with “without Reclamation” conditions where there is always some flow present.

Fish habitat and production in Emigrant Creek immediately downstream from the dam are substantially impacted when releases are terminated. ODFW electrofishing surveys, nonetheless, verify the presence of juvenile salmonids (i.e., steelhead) in this stream reach (Ritchey 2001).

Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages or critical habitat for coho salmon in Emigrant Creek.

Bear Creek Streamflows below Ashland Creek

Bear Creek begins 4.5 miles below Emigrant Dam after Emigrant Creek joins Neil Creek. Aquatic habitat conditions in Bear Creek affected by operations include streamflow, water quality, and fish passage. Different streamflow conditions exist when water is diverted during the irrigation season than after irrigation releases stop each year.

Table 5-5 compares “without Reclamation” and “with Reclamation” monthly flows in Bear Creek below Ashland Creek.

Based on modeled results, “with Reclamation” results in major decreases in flow between February and June at this location compared to “without Reclamation” due to Emigrant Lake filling. Most major flow decreases occur during average (50 percent exceedance) and dry (90 percent exceedance) water years. Greatest flow decrease occurs in a normal February with “without Reclamation” flow of 203 cfs compared to “with Reclamation” flow of 100 cfs, a 51 percent decrease. At the 50 percent exceedance level, “with Reclamation” flows between February and June (range from 59 cfs to 146 cfs) would always be below the recommended OWRD instream flows for Bear Creek downstream from Walker Creek. “Without Reclamation” flows would normally be greater than recommended instream flows each month except May and June. The only increase in “with Reclamation” flow occurs in a dry June, with a “with Reclamation” flow of 27 cfs compared to a “without Reclamation” flow of 17 cfs, a 59 percent increase.

These flow effects would likely adversely affect fry, juvenile, and smolt life stages of coho salmon. Fry would likely be displaced into unsuitable habitat and exposed to predation. Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages or critical habitat for coho salmon in Bear Creek below Ashland Creek.

Bear Creek Streamflows at Medford

Table 5-5 compares “without Reclamation” and “with Reclamation” monthly flows in Bear Creek at Medford.

The “with Reclamation” results in major decreases in flow between February and June at this location compared to “without Reclamation” due to Emigrant Lake filling. Most major flow decreases occur during average (50 percent exceedance) and dry (90 percent exceedance) water years. Greatest flow decrease occurs in a normal February with “without Reclamation” flow of 259 cfs compared to “with Reclamation” flow of 136 cfs, a 47 percent decrease. At the 50 percent exceedance level, “with Reclamation” flows between February and June (range from 64 cfs to 176 cfs) would always be below the recommended OWRD instream flows for Bear Creek downstream from Walker Creek except for April. “Without Reclamation” flows would exceed recommended instream flows each month except June. The only increase in “with Reclamation” flow occurs in a dry June, with a “with Reclamation” flow of 19 cfs compared with a “without Reclamation” flow of 17 cfs, a 12 percent increase.

These flow effects would likely adversely affect fry, juvenile, and smolt life stages of coho salmon. Fry would likely be displaced into unsuitable habitat and exposed to predation. Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages or critical habitat for coho salmon in this reach of Bear Creek.

Bear Creek Streamflows above Jackson Creek

Table 5-6 compares “without Reclamation” and “with Reclamation” monthly flows in Bear Creek above Jackson Creek.

The “with Reclamation” results in major decreases in flow between February and June at this location compared to “without Reclamation”. Most major flow decreases occur during average (50 percent exceedance) and dry (90 percent exceedance) water years. Greatest flow decrease occurs in a dry April with “without Reclamation” flow of 59 cfs compared to “with Reclamation” flow of 19 cfs, a 68 percent decrease. The only increase in “with Reclamation” flow occurs in a dry June, with a “with Reclamation” flow of 19 cfs compared to a “without Reclamation” flow of 1 cfs, an 1800 percent increase. At the 50 percent exceedance level, “with Reclamation” flows between February and June (range from 93 cfs to 174 cfs) would always be below the recommended OWRD instream flows for Bear Creek downstream from Walker Creek except in April. “Without Reclamation” flows would exceed recommended instream flows each month.

These flow effects would likely adversely affect fry, juvenile, and smolt life stages of coho salmon except in an average or dry June when “with Reclamation” would benefit these life stages. Fry would likely be displaced into unsuitable habitat and exposed to predation.

Based on this analysis, the proposed action may affect, and is likely to adversely affect fry, juvenile, and smolt life stages or critical habitat for coho salmon in this reach of Bear Creek.

Irrigation districts, ODFW, and other entities reached an informal agreement in the early 1990s to maintain a year-round 10-cfs minimum flow throughout the length of Bear Creek (ODEQ 2001). The 10-cfs minimum flow has been met most of the time during nonirrigation season at the stream gages downstream from Ashland Creek (RM 20.3) and upstream from Jackson Street Diversion Dam (RM 9.9).

Effects on Young-of-Year Juveniles from July through September

The requirements of juvenile coho salmon during this time period include shallow gravel areas, rearing habitat consisting of a mixture of pools and riffles, instream and bank cover, average water temperatures of 10 °C (50 °F) to 15 °C (59 °F) in the summer, and low amount of fine sediments.

During this time period, Reclamation is releasing natural and stored flows from Howard Prairie Lake, Hyatt Reservoir, and Emigrant Lake into Emigrant and Bear Creeks. Infrequent diversions may occur from the upper tributaries of South Fork Little Butte Creek through Dead Indian and South Fork Little Butte collection canals during this period.

South Fork Little Butte Creek

Table 5-7 compares “without Reclamation” and “with Reclamation” July through September monthly flows in South Fork Little Butte Creek.

Moderate to minor flow changes occur in South Fork Little Butte Creek when comparing “with Reclamation” to “without Reclamation” July through September flows. In general, “with Reclamation” flows are less than or equal to “without Reclamation” flows during this period. Both modeled scenarios are always below the ODWR instream flow rights of 47 cfs for July and August and 38.6 cfs for September at the mouth of South Fork Little Butte Creek.

Warm summertime water temperatures are a major impediment to juvenile survival in South Fork Little Butte Creek. Summer water temperatures in South Fork Little Butte Creek upstream from lower South Fork Diversion Dam (approximately 20 miles) may be adversely affected by Federal diversions since Reclamation diverts an average of 15,500 acre feet of water annually from six diversion structures upstream from lower South Fork Diversion Dam (Vinsonhaler 2002). However, most of the stream exceeds the 64 °F summer ODEQ water temperature standard. Likely causes are natural low flows, some upstream water diversion by non-Federal water users, and lack of riparian shading.

Overall, generally moderate-minor flow decreases compared to "without Reclamation" may affect young-of-the-year juvenile coho during the July – September period as a result of the proposed action. Availability of river edge habitat with appropriate cover elements could becomed limited, which may reduce the value of thermal refugia. Federal water operations are likely to affect water temperatures in some stream reaches, depending on the water year type.

Based on this analysis, the proposed action may affect, and is likely to adversely affect young-of-year juveniles or critical habitat for this life stage of SONCC coho salmon in South Fork Little Butte Creek.

Little Butte Creek

Table 5-7 compares "without Reclamation" and "with Reclamation" July through September monthly flows in Little Butte Creek at Lake Creek.

Little Butte Creek downstream from North Fork and lower South Fork Little Butte Creek Diversion Dams, overall, does not provide good year-round juvenile rearing conditions due to seasonal diversions for irrigation.

Based on modeled results, "with Reclamation" results in major flow increases in average and wet water years compared to "without Reclamation" flows. No flow changes occur during dry water years (90 percent exceedance). Water quality monitoring shows Little Butte Creek retains high summer water temperatures which preclude any meaningful production of juvenile salmonids, except for fall Chinook salmon. Factors elevating water temperature include shallow water conditions, low thermal mass allowing greater heating during the day, and low flow velocity.

Both modeled scenarios exceed OWRD instream flow rights for Little Butte Creek at the mouth in July and August (20 cfs) during average water years, but the flow recommendation of 120 cfs in September is never met by either modeled scenario. Therefore, Little Butte Creek temperatures would still likely exceed the Oregon standard even if the Rogue River Basin Project did not operate.

Senior non-Federal irrigation rights may not allow OWRD summertime instream flow rights to be met downstream from the upper South Fork tributary diversions.

A small, unquantified, portion of irrigated lands drain toward Little Butte Creek. Return flows to the stream are minimal; therefore, water quality impacts related to return flows are minimal (Reclamation 2001b). Overall, young-of-the-year coho salmon or critical habitat should not be affected by operations July through September in Little Butte Creek.

Based on this analysis, the proposed action will have no effect on young-of-year juveniles or critical habitat for this life stage of SONCC coho salmon in the mainstem Little Butte Creek.

Antelope Creek

No summertime diversions occur at Antelope Creek Diversion Dam; therefore, stream water temperatures downstream from this diversion are unaffected by operations. Thus, the proposed action will have no effect on young-of-year juveniles or critical habitat for this life stage of SONCC coho salmon in Antelope Creek.

Bear Creek and Emigrant Creek

Water quality problems in Bear Creek are related to irrigated agriculture, high population density, and community development in Bear Creek watershed.

Table 5-5 and Table 5-6 compare “without Reclamation” and “with Reclamation” monthly flows in Bear Creek at various locations between July and September.

Compared to “without Reclamation” conditions, “with Reclamation” increases summertime flows dramatically in most of the length of Bear Creek (Table 5-5 and Table 5-6). “With Reclamation” flows exceed OWRD flow recommendations for Bear Creek downstream from Walker Creek in August (59 cfs) and September (27 cfs), but are less than flow recommendations in July at the 50 percent exceedance level. Warm water temperatures may preclude juvenile salmonid rearing and survival in most reaches under either scenario.

Storage releases from Emigrant Dam directly influence streamflow which can then affect water quality conditions. Summer fish habitat conditions up and down the length of Bear Creek are likely to be adversely affected by summer/fall irrigation operations even though flows are higher than what occurred prior to Project development. Aquatic macroinvertebrates cannot establish on streambed substrates that are constantly subject to wetting and drying from wide flow fluctuations. Juvenile fish can be stranded in isolated pools when stream reaches rapidly dewater. Past fish surveys found few juvenile coho salmon and steelhead rearing in mainstem Bear Creek. Most habitat conditions in mainstem Bear Creek, except for fall Chinook salmon, appear unfavorable for salmonids, and warm water temperatures are likely a significant major limiting factor for coho salmon and steelhead survival.

Analysis of data collected in Bear Creek and its tributaries has shown substantial summertime exceedence of the Oregon water temperature standard. In general, climatic variables, air temperatures, solar radiation, humidity, and time of year probably have the greatest effect on Bear Creek water temperatures. Additional riparian vegetation restoration is needed to increase summer shading of stream surfaces. Recent Reclamation (2001b) studies show mixed temperature effects, both positive and negative, relative to irrigation return flows to Bear Creek and its tributaries. Federal water operations probably contribute to summertime elevated water temperatures but are not the sole source. Irrigation return flows to Bear Creek, via tributaries, probably have some effect (positive or negative) on the instream temperature in Bear Creek, depending on the tributary, and the relative magnitude of the streamflows in Bear Creek and in the tributary (Reclamation 2001b). That is, if the flow in Bear Creek is high compared to the tributary, then the effect would be insignificant. If the flow in the trbutary is large compared to Bear Creek, then the water temperature would be similar to that of the tributary. The instream temperatures of the tributaries at the confluence with Bear Creek are sometimes higher and, at other times, are lower than the water temperatures in Bear Creek depending on the specific tributary and time period during the summer months.

About 20 tributaries increase Bear Creek flow during nonirrigation season. Water withdrawn from these small streams during irrigation season probably has adverse effects on juvenile fish rearing. Irrigation withdrawals deplete some reaches of these creeks while other sections could have increased flow from irrigation water conveyance. The overall result is reduced quality and quantity of habitat for rearing juvenile fish (e.g., pool quality, thermal refugia).

Based on this analysis, the proposed action may affect, and is likely to adversely affect young-of-year juvenile fish or critical habitat for this life stage of SONCC coho salmon in Emigrant Creek and in mainstem Bear Creek.

Effects on Adult Migration and Spawning from October through February

During this time, the requirements of adult coho salmon include a migratory corridor with suitable water depth and velocities, resting pools, and adequate water quality conditions. Successful migration also depends on adequate fish passage conditions in the main stem river and access to tributaries.

During October, Reclamation is releasing natural and stored flows from Howard Prairie Lake, Hyatt Reservoir, and Emigrant Lake into Emigrant and Bear Creeks. Infrequent diversions may occur from the upper tributaries of South Fork Little Butte Creek through Dead Indian and South Fork Little Butte collection canals during this period.

During November through February, Reclamation is diverting water through Dead Indian and South Fork Little Butte collection canals for storage in Howard Prairie Lake and storing natural flow water in Emigrant Lake.

South Fork Little Butte Creek

Table 5-7 compares "without Reclamation" and "with Reclamation" October through February monthly flows in South Fork Little Butte Creek.

"With Reclamation" streamflows in South Fork Little Butte Creek near Lake Creek would be less than "without Reclamation" from October through February. Greatest precentage decreases would occur during drier years, ranging from a reduction of 3 cfs or 18 percent in October to a reduction of 17 cfs or 41 percent in December at the 90 percent exceedance level. Minor and moderate effects would occur in wet years. Mean "with Reclamation" and "without Reclamation" flows would meet or exceed ODWR instream flow rights in South Fork Little Butte Creek at the mouth in November, December, and January, but would be less than recommended flows in October. Only mean "with Reclamation" flows would be less than recommended flows in February. These recommended flows consider flows necessary to meet depth and velocity criteria for fish passage and spawning. Thus, "with Reclamation" may adversely affect adult coho migrations in South Fork Little Butte Creek in dry water years, particularly in October, primarily because of shallow depths and slow velocities for passage and spawning.

Based on this analysis, the proposed action may affect, and is likely to adversely affect upstream migrating and spawning fish or critical habitat for this life stage of SONCC coho salmon in the South Fork of Little Butte Creek.

Little Butte Creek

Table 5-7 compares "without Reclamation" and "with Reclamation" October through February monthly flows in Little Butte Creek at Lake Creek.

The following discussion refers to the entire mainstem Little Butte Creek below diversions to the mouth of the Rogue River. In general, "with Reclamation" results in increased flows compared to "without Reclamation", particularly in dry water years.

Major flow increases occur in October and November. Minor flow decreases occur in wet years during November through February. The OWRD instream flow rights for Little Butte Creek at the mouth are exceeded by "with Reclamation" flows November through February in average water years. "With Reclamation" flow of 55 cfs during an average October is less than the recommended flow of 120 cfs for this month. Low fall flow in Little Butte Creek in some dry years, like 2000, may limit upstream migration and spawning of fall Chinook salmon, steelhead, and coho salmon under either modeled scenario. These fish will distribute farther and higher into the watershed in wetter years. No canal stream crossings exist in Little Butte Creek watershed that cause fish passage problems. Compared to "without Reclamation," "with Reclamation" is not likely to adversely affect coho salmon migration and spawning in Little Butte Creek during this period.

Based on this analysis, the proposed action may affect, and is not likely to adversely affect upstream migrating and spawning fish or critical habitat for this life stage of SONCC coho salmon in the Little Butte Creek mainstem.

Antelope Creek

Coho salmon are able to use the lower 6.3 miles of Antelope Creek (Ritchey 2001). Good flow conditions for adult coho salmon migration and spawning are probably of short duration in Antelope Creek. This is a result of diversions at the Antelope Creek Diversion Dam (see Fish Passage section below). This is likely to adversely affect coho salmon migration and spawning.

Diversions during high flows impact adult migrants trying to reach spawning grounds. A minimum 1-cfs flow must be passed at the diversion from November through March. This minimum flows is not likely sufficient to provide adequate instream fish passage. There is no stream gage to record how often these minimum flows occur.

Based on this analysis, the proposed action may affect, and is likely to adversely affect upstream migrating and spawning fish or critical habitat for this life stage of coho salmon in Antelope Creek.

Emigrant Creek and Bear Creek

Table 5-5 and Table 5-6 compare "without Reclamation" and "with Reclamation" monthly flows in Bear Creek at various locations between October and February.

During October, there are major flow increases as a result of the "with Reclamation" throughout Bear Creek. This does not include Emigrant Creek below Emigrant Dam down to Neil Creek. These flow increases are most notable during drier water years. However, between November and February, "with Reclamation" flows are usually less than "without Reclamation" flows throughout Bear Creek. Most major flow decreases occur in January and February due to Emigrant Lake filling and may adversely affect coho adult fish passage into tributaries to spawn. Bear Creek tributaries provide most of the flow to Bear Creek unless flood control management releases are made from Emigrant Lake. As a result, upper Bear Creek flow may not be adequate for salmon and steelhead migration and spawning. In fact, no streamflow resulting from "with Reclamation" occurs in Emigrant Creek below Emigrant Dam during average and dry water years between October and February. The OWRD flow recommendations for Bear Creek downstream from Walker Creek are not met by the "with Reclamation" during average water years from October through February (i.e., Bear Creek below Ashland Creek). These flow recommendations are only met in October at Medford and above Jackson Creek.

There is the potential effect during the spawning/egg incubation period of dewatering of incubating eggs in Bear Creek if flows decline. Hydrologic modeling results indicate under both modeled scenarios flows generally decline between December and March in wet water years. Thus, lower flows resulting from the "with Reclamation" and "without Reclamation" between December and March may result in some dewatering of incubating coho salmon eggs in the mainstem Bear Creek during wet years.

Based on this analysis, the proposed action may affect, and is likely to adversely affect upstream migrating and spawning fish or critical habitat for this life stage of SONCC coho salmon in lower Emigrant Creek and in mainstem Bear Creek.

Fish Passage

Little Butte Creek Watershed

Federal Facilities

Adult fish passage facilities at Antelope Creek Diversion Dam were totally upgraded in 1997-1998. Adult passage is provided by a pool and weir facility.

Water is diverted in winter and spring during these higher flow periods and, as a result, probably affects opportunistic spawner migration in stream reaches downstream from the diversion. Diversions during high flows inhibit passage of adult migrants trying to reach spawning grounds. Likewise, higher flows for spring smolt migration are limited as water can also be withdrawn at this time. A minimum 1-cfs flow must be passed at the diversion from November through March and 2 cfs the rest of the year. These minimum flows are unlikely sufficient to provide adequate instream fish passage. There is no stream gage to record how often these minimum flows occur.

Bear Creek Watershed

Federal Facilities

Juvenile fish passage at the Oak Street and Phoenix Canal diversion dams was modified in the late 1990s to meet NMFS design and criteria. Most canals cross Bear Creek's fish-bearing tributaries by buried siphons or overhead flumes (Ashland, East, West, Talent, and Hopkins Canal) and cause no fish passage delays.

The Phoenix Canal (interrelated and interdependent facility) traverses Coleman and Griffin Creeks using temporary diversion check dams that block passage to migrating fish. Stoplog boards are installed during irrigation season to divert the stream to the canal. The structures may waste some water to meet downstream diversion rights.

No fish passage provisions currently exist at these structures. Downstream migrant smolt or juvenile fish would be forced to enter the Phoenix Canal and will likely be lost to the system.

Juvenile fish passage at Jackson Street Diversion Dam (interrelated and interdependent facility) was modified in the late 1990s to meet NMFS design and criteria.

6.2.2 Klamath River Basin

Hydrology and Summer Water Temperature Approach

The proposed action affects the Klamath River basin due to diversions from Jenny Creek in the Klamath River basin which enter the Rogue River basin.

The Klamath River basin analyses were developed from modeled hydrologic and water quality data originally presented in the February 25, 2002, Klamath BA and modified to represent "with Reclamation" as directed by the 2002 Biological Opinion on the Klamath BA.

"With Reclamation" flows were compared with "without Reclamation" flows to assess effects on coho salmon. Iron Gate Dam forms a permanent fish passage barrier to any further migration upstream in the Klamath River.

The KPOPSIM Hydrology Model was used to simulate “without Reclamation” and “with Reclamation” stream flows in the Klamath River basin. The “with Reclamation” scenario was based on Klamath Project operations proposed for 2003, including a 50 TAF “water bank” for Iron Gate Dam flows. The comparison of the “with Reclamation” to the “without Reclamation” demonstrates the effects of keeping Jenny Creek flows in the Klamath River basin.

Jenny Creek is a tributary to the Klamath River above Iron Gate Reservoir and drains approximately 205 square miles before entering Iron Gate Reservoir. For the Klamath River basin “without Reclamation”, Jenny Creek water values were simulated as additional flow gains (Table 6-1) to the Klamath Project KPOPSIM model for water years 1961 through 2001. For the Rogue River Basin Project, this was interpreted as monthly distribution of computed annual Jenny Creek contributions to the Rogue River basin. As a result of the Rogue River Basin Project transbasin diversion, Jenny Creek was determined to contribute, on average, 24,230 acre-feet per water year to the Rogue River basin. Pre-Klamath Project estimated average annual flow at Iron Gate for a normal water year, which accounts for accretions in flow below Keno, was approximately 1.8 million acre-feet (Balance Hydrologics, Inc. 1996). Thus, Jenny Creek contributes approximately 1.3 percent of the total water balance in the upper Klamath River basin.

As a result of the “with Reclamation,” flows in the mainstem Klamath River will be slightly affected by releases from Iron Gate Dam (Table 6-2). This is illustrated by comparing the “with Reclamation” flows in the Klamath River downstream from Iron Gate Dam to the “without Reclamation” flows (Jenny Creek inflows) for each water year type (figures 6-1 through 6-10). These “with Reclamation” flows were compared to “without Reclamation” operation flows to assess effects on coho salmon.

Table 6-1. Jenny Creek Flow Gains into Klamath River Basin (cfs)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Sep
1961	5	6	19	30	75	117	117	137	137	50	50	14	14	7	7	4	4
1962	2	3	8	13	33	51	51	59	59	22	22	6	6	3	3	2	2
1963	2	3	10	16	39	61	61	72	72	26	26	7	7	4	4	2	2
1964	4	6	18	28	70	110	110	128	128	47	47	13	13	6	6	4	4
1965	5	7	21	33	81	126	126	148	148	54	54	15	15	7	7	5	5
1966	5	6	19	30	75	117	117	137	137	50	50	14	14	7	7	4	4
1967	3	4	11	17	42	65	65	77	77	28	28	8	8	4	4	2	2
1968	5	8	23	37	91	142	142	167	167	61	61	17	17	8	8	5	5
1969	2	3	8	12	30	46	46	54	54	20	20	6	6	3	3	2	2
1970	3	5	14	23	56	88	88	103	103	37	37	11	11	5	5	3	3
1971	4	5	15	24	60	94	94	110	110	40	40	11	11	5	5	3	3
1972	4	6	17	27	68	106	106	124	124	45	45	13	13	6	6	4	4
1973	4	6	19	30	73	114	114	133	133	49	49	14	14	7	7	4	4
1974	3	5	14	23	56	88	88	102	102	37	37	11	11	5	5	3	3
1975	4	6	19	30	75	116	116	136	136	50	50	14	14	7	7	4	4
1976	4	6	17	27	67	104	104	122	122	44	44	13	13	6	6	4	4
1977	5	8	23	37	91	142	142	166	166	60	60	17	17	8	8	5	5
1978	2	3	7	12	29	45	45	53	53	19	19	6	6	3	3	2	2
1979	2	4	11	17	41	64	64	75	75	27	27	8	8	4	4	2	2

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Sep
1980	4	6	16	26	64	100	100	117	117	43	43	12	12	6	6	4	4
1981	5	7	20	32	80	124	124	145	145	53	53	15	15	7	7	5	5
1982	4	6	17	26	66	102	102	120	120	44	44	12	12	6	6	4	4
1983	5	8	23	36	90	141	141	165	165	60	60	17	17	8	8	5	5
1984	6	8	24	38	94	146	146	171	171	62	62	18	18	8	8	5	5
1985	5	8	23	36	88	137	137	161	161	59	59	17	17	8	8	5	5
1986	6	8	25	39	96	150	150	175	175	64	64	18	18	9	9	6	6
1987	7	9	28	44	110	171	171	201	201	73	73	21	21	10	10	6	6
1988	7	10	29	46	113	177	177	207	207	75	75	21	21	10	10	6	6
1989	3	4	11	17	43	67	67	78	78	29	29	8	8	4	4	2	2
1990	3	4	11	18	44	68	68	79	79	29	29	8	8	4	4	2	2
1991	3	4	11	17	42	65	65	76	76	28	28	8	8	4	4	2	2
1992	4	6	19	30	74	115	115	135	135	49	49	14	14	7	7	4	4
1993	0	0	1	1	3	4	4	5	5	2	2	1	1	0	0	0	0
1994	5	7	22	35	87	135	135	158	158	57	57	16	16	8	8	5	5
1995	0	0	0	0	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0
1996	6	8	24	37	92	144	144	168	168	61	61	17	17	8	8	5	5
1997	6	8	24	37	93	144	144	169	169	61	61	18	18	8	8	5	5
1998	2	3	8	13	31	49	49	57	57	21	21	6	6	3	3	2	2
1999	2	3	8	13	33	52	52	60	60	22	22	6	6	3	3	2	2

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Sep
2000	6	8	24	37	92	144	144	168	168	61	61	17	17	8	8	5	5
2001	4	6	18	28	70	110	110	128	128	47	47	13	13	6	6	4	4
AVG	4	6	17	26	65	101	101	118	118	43	43	12	12	6	6	4	4

Table 6-2. Percent Changes in Flows at Iron Gate Dam in the Klamath River with Jenny Creek Contributions (cfs)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Sep
1961	0.3	0.2	0.8	2.0	2.9	3.9	5.9	6.8	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	1.9	0.1	0.4	0.9	1.4	2.2	2.4	1.9	1.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.3	0.1	0.3	0.5	2.5	2.8	2.7	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.7	0.3	1.2	1.2	3.2	6.0	6.1	4.2	4.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	1.8	0.2	0.4	1.2	3.0	3.0	5.5	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	1.8	0.2	1.0	1.3	3.5	5.1	4.4	4.7	3.4	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	1.3	0.4	0.0	1.3	2.3	2.2	0.0	0.2	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0
1968	1.2	0.5	1.6	2.0	2.8	5.0	4.9	0.0	2.0	3.7	4.7	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	1.3	1.1	1.5	1.4	1.0	1.0	0.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.7	0.3	0.5	0.3	1.4	2.7	2.7	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.7	0.5	0.5	1.9	1.8	1.8	1.8	1.8	0.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.7	0.2	0.7	0.9	1.3	1.0	1.0	3.2	3.2	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
1973	0.8	0.3	0.7	1.0	2.5	5.6	2.8	0.1	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
1974	0.0	0.6	0.4	0.4	1.7	1.6	1.6	1.6	1.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	0.7	0.3	0.9	1.1	2.1	3.0	2.4	3.2	3.2	1.2	1.4	0.0	1.8	0.0	0.0	0.0	0.0
1976	0.4	0.2	0.7	1.0	2.2	4.6	4.1	5.1	0.6	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.7	0.3	0.0	2.2	7.4	15.0	19.0	18.9	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	0.0	0.0	0.6	0.6	0.9	1.3	1.3	1.5	1.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Sep
1979	0.4	0.0	0.7	0.7	1.7	2.8	3.3	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	1.0	0.8	0.6	1.9	4.2	4.2	5.7	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	5.6	4.7	7.2	7.5	11.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.0	1.5	0.3	0.9	0.8	1.8	1.8	2.1	2.1	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.8	0.3	0.8	1.3	1.5	1.9	1.9	2.9	2.9	0.0	1.6	0.0	1.5	0.0	0.0	0.0	0.0
1984	0.6	0.2	0.4	1.0	1.4	2.4	2.4	3.2	3.2	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.9	0.2	0.9	1.6	3.7	4.3	4.3	3.7	3.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.4	0.4	1.2	1.2	1.3	2.2	2.2	6.0	6.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.9	0.5	1.3	2.0	3.7	7.6	7.7	6.8	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	3.2	1.3	2.2	1.8	7.8	15.6	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	7.7	1.0	1.1	1.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.4	0.2	0.8	0.8	2.1	2.5	3.3	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	5.8	6.6	18.5	6.5	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	26.3	14.6	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.3	0.6	1.7	0.0	10.6	12.8	11.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	0.6	0.8	0.9	1.0	3.1	3.1	4.8	4.8	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
1997	1.9	0.3	0.5	0.6	1.8	5.1	5.1	7.7	1.1	2.3	0.0	1.2	1.2	0.0	0.0	0.0	0.0

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Sep
1998	0.8	0.1	0.4	0.3	0.8	1.0	1.0	1.4	1.4	0.4	0.4	0.2	0.2	0.0	0.0	0.0	0.0
1999	0.3	0.1	0.3	0.4	0.7	0.8	0.8	0.0	0.5	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.7	0.4	0.2	1.2	2.4	4.5	4.5	6.4	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.4	0.4	1.2	1.9	8.6	9.1	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVG	0.5	0.4	0.6	1.0	3.2	4.2	4.7	3.2	3.0	0.7	0.6	0.1	0.1	0.0	0.0	0.0	0.0

The water quality temperature analysis looked at the Klamath River from Iron Gate Dam to Seiad Valley. The method used to determine the effects of proposed water delivery and storage on threatened coho salmon in the mainstem Klamath River was to compare flows as modeled at Iron Gate Dam resulting from the “with Reclamation” and the “without Reclamation” flow releases in the mid-June to September period when high water temperatures and low dissolved oxygen levels create an unfavorable environment for salmon. Effects of summer Klamath River flows on water temperature were determined from RMA-11 model simulations (Deas and Orlob 1999). Although river flow can directly impact water temperatures in Klamath River (Deas 2000), there is a lack of data demonstrating a clear association between changes in Klamath River flow and health of coho salmon.

Figure 6-1 through Figure 6-5 illustrate flows as measured at Iron Gate Dam with the “with Reclamation” and “without Reclamation” flows for coho salmon for each water year type. Figure 6-6 through Figure 6-10 compare “with Reclamation” and “without Reclamation” conditions Klamath River simulated flows between Shasta River and Scott River confluences for each water year type.

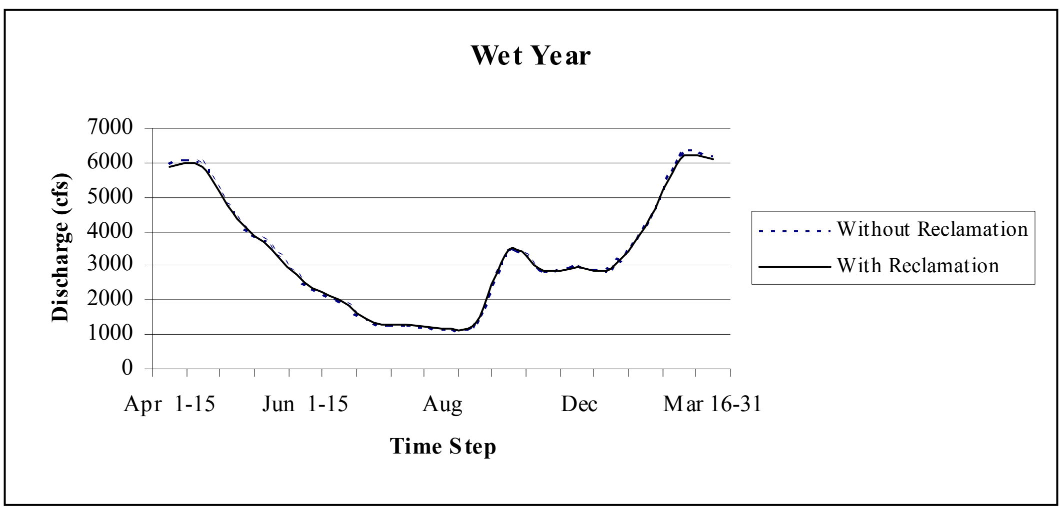

Figure 6-1. Iron Gate Dam flows during “wet” water year type under “with Reclamation” and “without Reclamation” conditions.

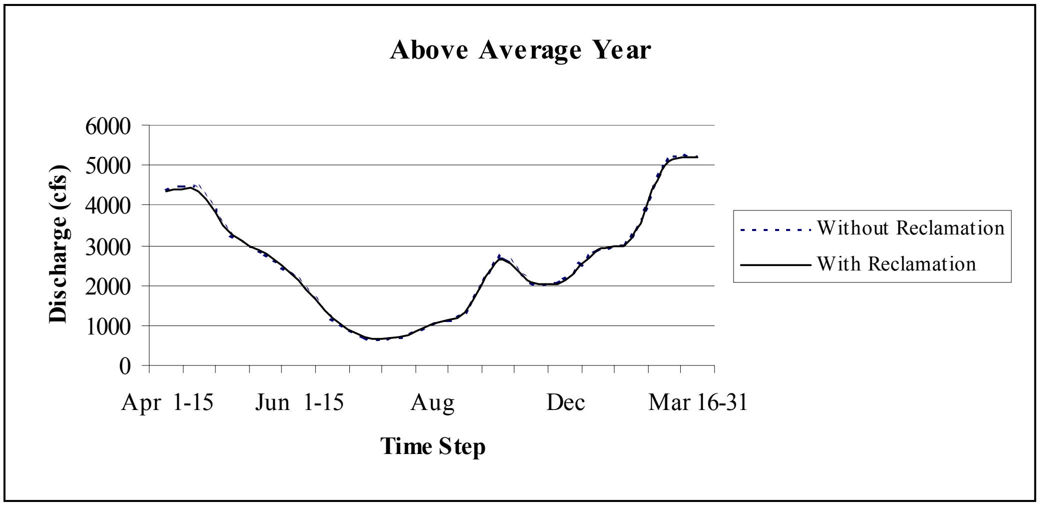

Figure 6-2. Iron Gate Dam flows during "above average" water year type under "with Reclamation" and "without Reclamation" conditions.

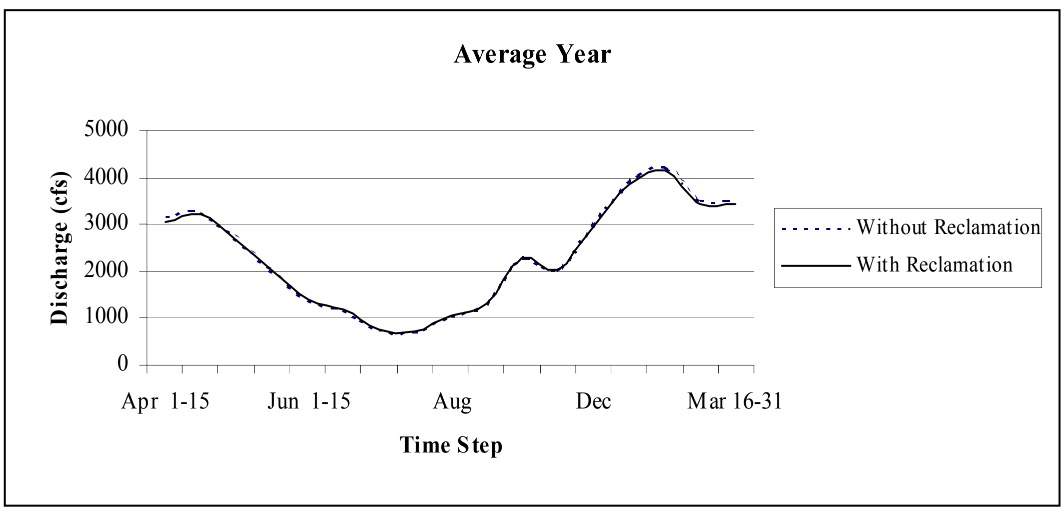

Figure 6-3. Iron Gate Dam flows during "average" water year type under "with Reclamation" and "without Reclamation" conditions.

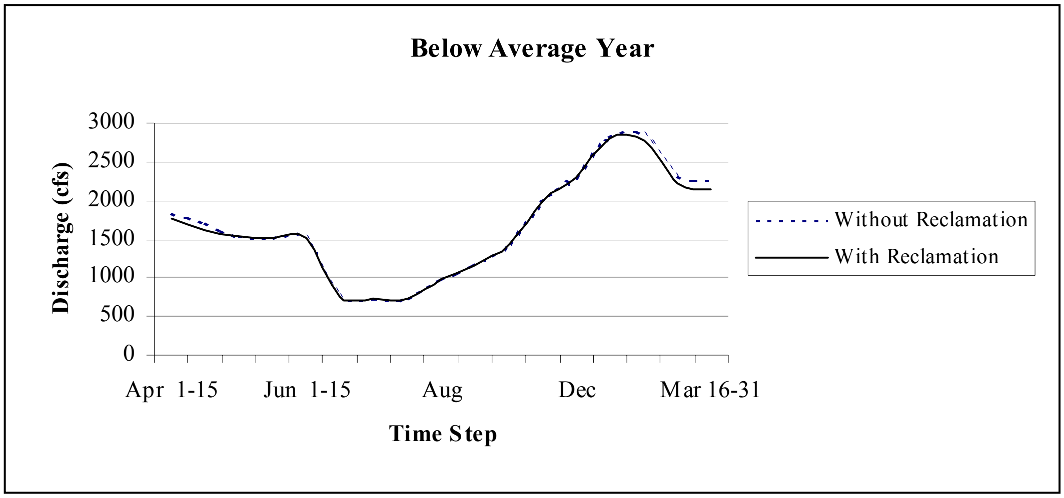

Figure 6-4. Iron Gate Dam flows during "below average" water year type under "with Reclamation" and "without Reclamation" conditions.

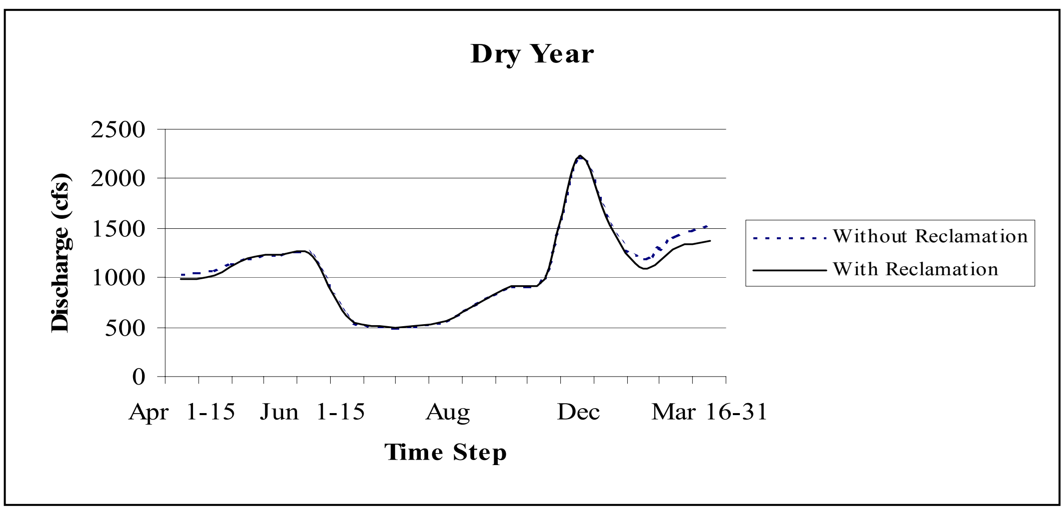

Figure 6-5. Iron Gate Dam flows during "dry" water year type under "with Reclamation" and "without Reclamation" conditions.

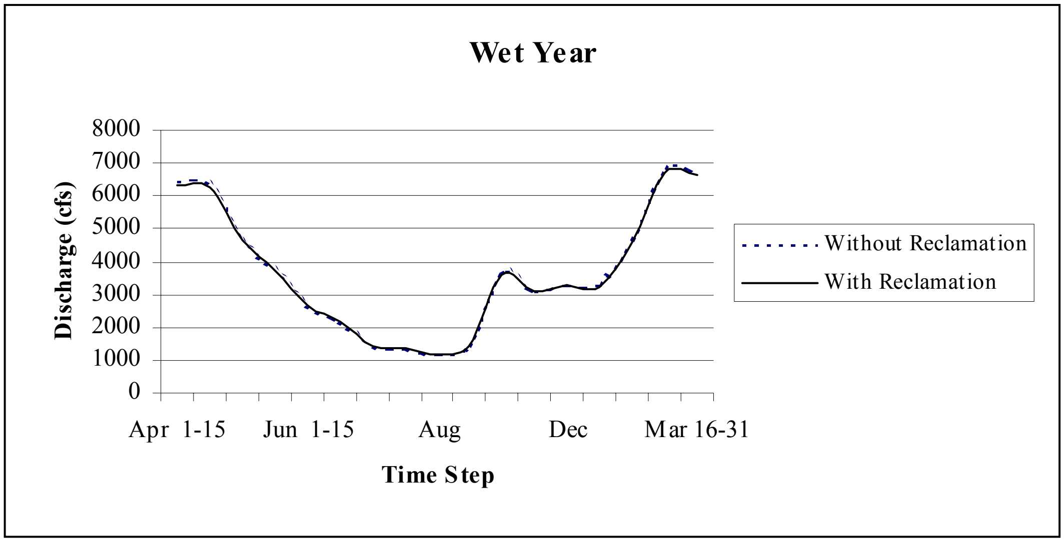

Figure 6-6. Klamath River flows between Shasta River and Scott River confluences during "wet" water year type under "with Reclamation" and "without Reclamation" conditions.

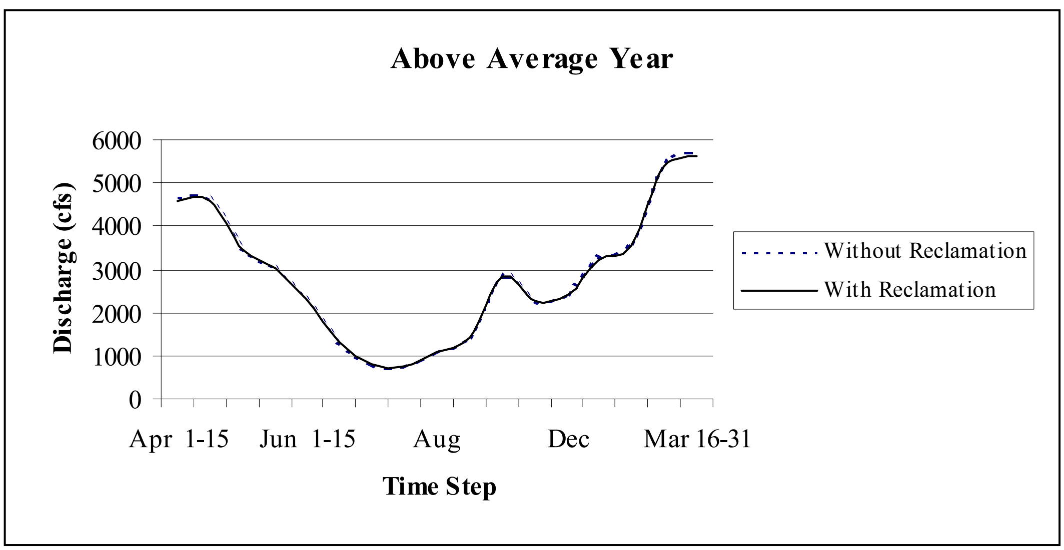

Figure 6-7. Klamath River flows between Shasta River and Scott River confluences during "above average" water year type under "with Reclamation" and "without Reclamation" conditions.

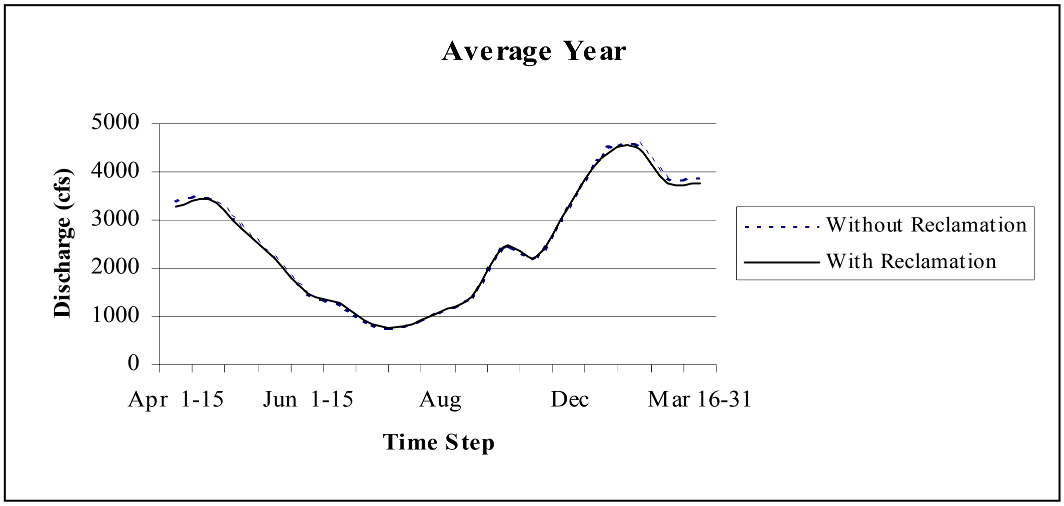

Figure 6-8. Klamath River flows between Shasta River and Scott River confluences during "average" water year type under "with Reclamation" and "without Reclamation" conditions.

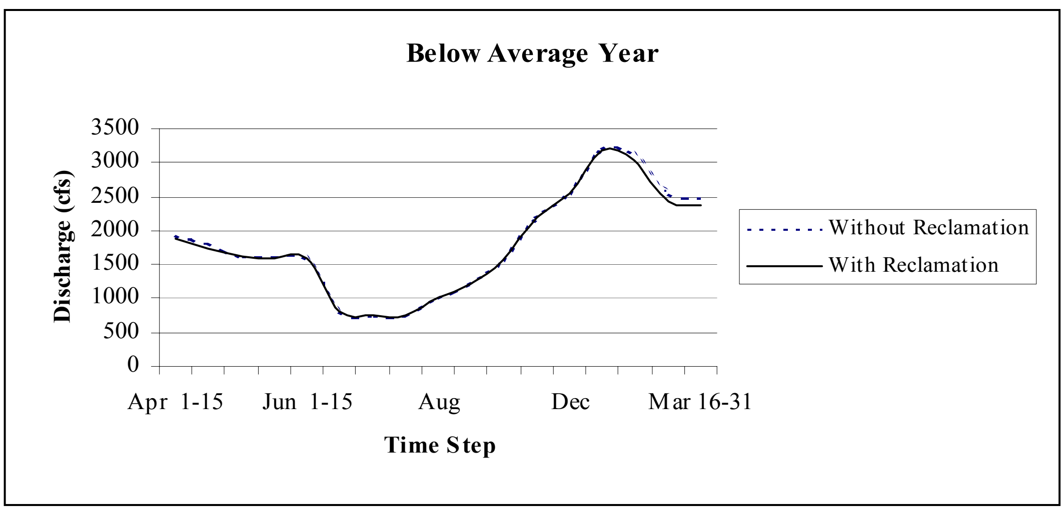

Figure 6-9. Klamath River flows between Shasta River and Scott River confluences during "below average" water year type under "with Reclamation" and "without Reclamation" conditions.

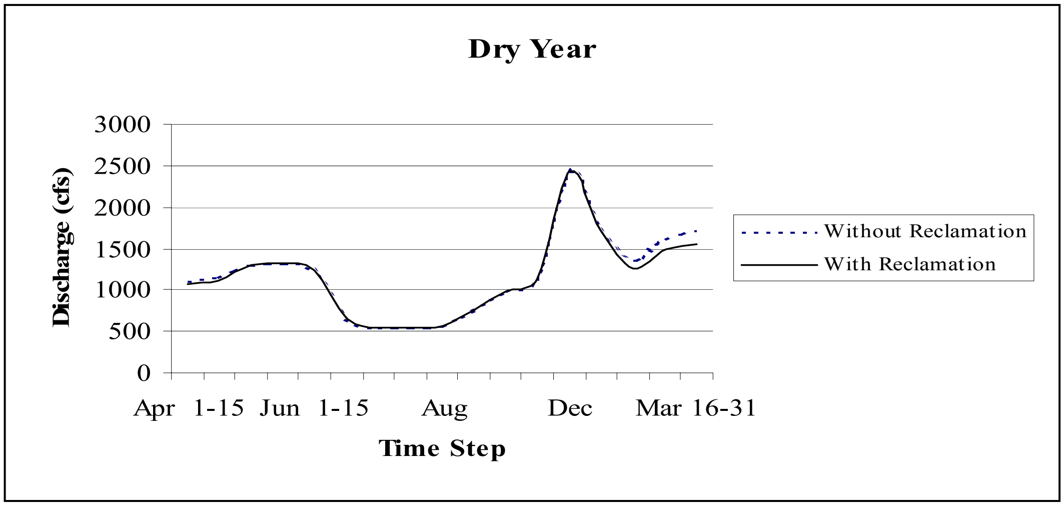

Figure 6-10. Klamath River flows between Shasta River and Scott River confluences during "dry" water year type under "with Reclamation" and "without Reclamation" conditions.

Habitat Approach

The habitat analysis study area included the Klamath River from Iron Gate Dam downstream to the confluence with Scott River. The habitat analysis was based on the periodicity of fry and spawning life stages of coho salmon in the Klamath River. Coho salmon fry occur in mainstem Klamath River from February to June (Hardy and Addley 2001). Most spawning occurs from November to January (Hassler 1987). The underlying assumption for the habitat analysis is that suitable macrohabitat (channel characteristics, water quality, and water temperature) occurs throughout the river reach for coho salmon.

Habitat versus flow relationships for anadromous fishes in the Klamath River mainstem were developed by Hardy and Addley (2001). The general assumption underlying habitat modeling is that aquatic species will react to changes in the hydraulic environment (Hardy and Addley 2001). In general, the relationship between flow and habitat starts at the origin (no flow, no habitat), increases (not necessarily in a uniform manner) with flow up to a point, and then declines if flows become excessive. These "habitat versus flow" relationships were developed by first determining the hydraulic characteristics (e.g., depth and velocity) of the Klamath River mainstem channel between Iron Gate Dam and the Shasta River confluence and between Shasta River and Scott River as a function of discharge. This information was then integrated with habitat suitability criteria to produce a measure of available habitat (percent of optimal habitat) as a function of discharge (Hardy and Addley 2001). Habitat suitability criteria describe biological responses of target species and life stages to the hydraulic environment (i.e., how suitable a particular gradient of depth, velocity, substrate, cover, etc., is to a target species and life stage). For example, habitat suitability as a function of depth is represented on a scale of 0.0 to 1.0. A suitability value of 0.0 represents a depth that is wholly not suitable, while a 1.0 value indicates a depth that is "ideally" suitable. Figure 6-11 and Figure 6-12 are graphic representations of the data in Table 6-3 and Table 6-4. Specific relationships between the status of salmon and Klamath River flow amounts have not been established.

Table 6-3. Habitat-discharge relationships for salmon in Klamath River (Iron Gate Dam-Shasta River)

Discharge (cfs)	Percent of optimal habitat	
	Chinook spawn	Coho fry
500	66	59
713	81	46
927	91	44
1140	97	44
1393	100	47
1647	100	48
1900	97	51
2191	90	58
2482	82	65

Discharge (cfs)	Percent of optimal habitat	
	Chinook spawn	Coho fry
2773	74	71
3064	65	76
3365	57	81
4086	40	91
4817	28	97
5548	21	100
6365	16	89
7183	13	85
8000	12	81

Source: Hardy and Addley (2001)

Table 6-4. Habitat-discharge relationships for salmon in Klamath River

Discharge (cfs)	Percent of Optimal Habitat	
	Chinook spawn	Coho fry
912	100	18
1224	97	22
1629	88	30
2034	77	36
2671	65	54
3309	57	68
3946	52	79
4584	48	89
5221	45	96
5858	43	100
6496	41	95
7332	40	87
8169	38	78
9005	36	68

Source: Hardy and Addley (2001)

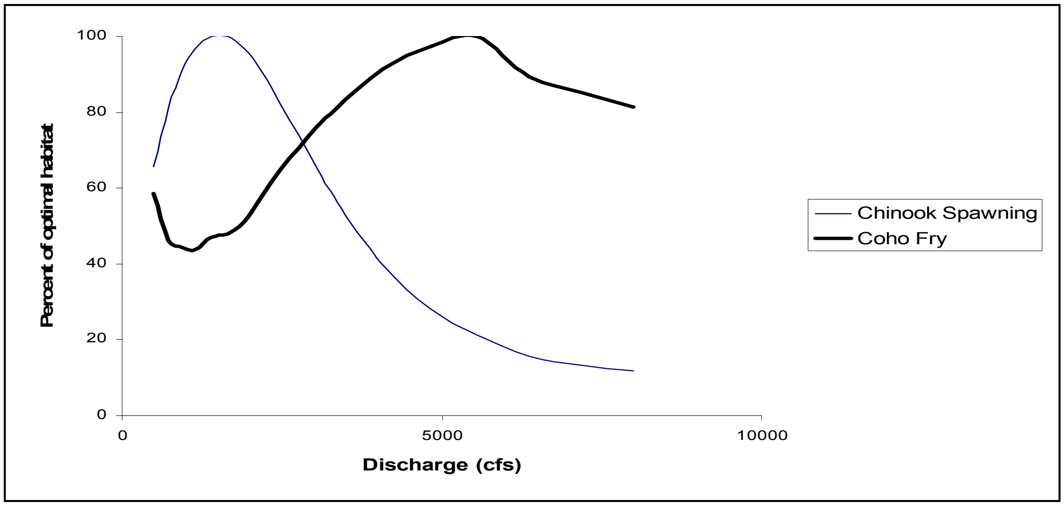

Figure 6-11 . Habitat discharge relationships for coho fry and Chinook spawning in Klamath River, Iron Gate Dam to Shasta River (Hardy and Addley 2001).

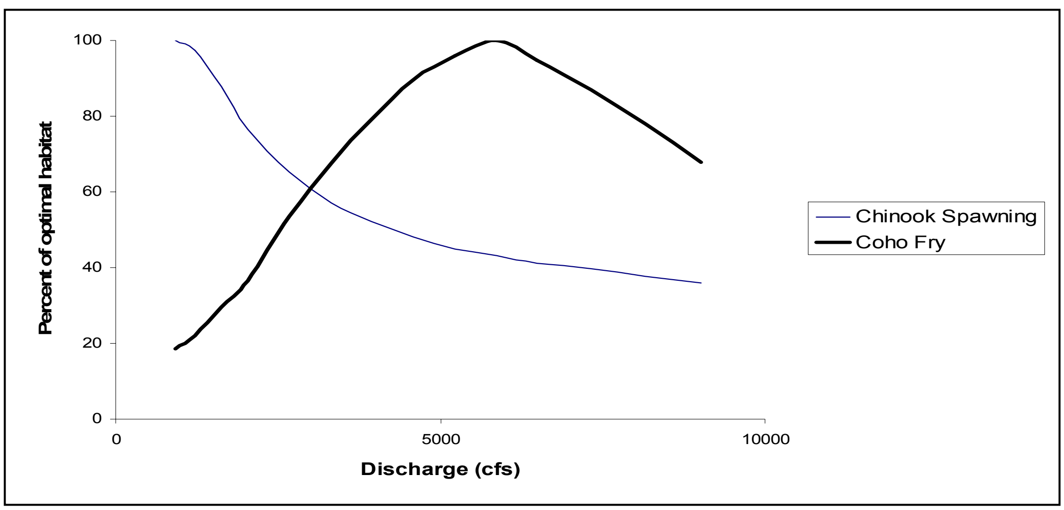

Figure 6-12. Habitat - discharge relationships for coho fry and Chinook spawning in Klamath River, Shasta River-Scott River. Source: Hardy and Addley (2001)

The following approach was used to determine the effects of the proposed action on coho salmon habitat in the Klamath River. The Klamath mainstem “without Reclamation” flows and flows resulting from the “with Reclamation” (Figure 6-6 through Figure 6-10) were integrated with the preliminary Iron Gate Dam to Shasta River and Shasta River to Scott River habitat (percent of optimal habitat) versus discharge (cfs) relationships from the Hardy and Addley (2001) study for coho fry and Chinook spawning life stages (Table 6-3 and Table 6-4; Figure 6-11 and Figure 6-12) to construct two sets of habitat values (“with Reclamation” and “without Reclamation” scenarios). There is no available information on the relationship between Klamath River flows and coho salmon spawning habitat. However, since fall Chinook salmon utilize the mainstem Klamath River for spawning during the same period that coho salmon spawn (INSE 1999), Chinook spawning was considered the best surrogate life stage for coho migration and spawning.

These life stages were considered the highest priority for the following time periods:

- Coho fry from February - June 15
- Coho/Chinook spawning from October - February

The impact assessment for coho fry was determined based on the percentage difference between the habitat values “with Reclamation” and “without Reclamation.” For purposes of this analysis, habitat effects due to the “with Reclamation,” as a percentage of “without Reclamation”, were considered minor if less than or equal to 10 percent; moderate between 11-20 percent; and major more than 20 percent. The rationale for these percentages is similar to that used by NMFS (2002). In their analysis, they assumed potential errors of 10 percent associated with stream gaging estimates and stream habitat modeling. Percent changes greater than 10 percent would more likely reflect actual habitat changes. In addition, NMFS (2002) felt that fry habitat should not be reduced by more than 20 percent of baseline conditions as a long-term target. For this BA, a similar analysis was done for Chinook salmon spawning to assess effects on spawning and egg incubation habitat in the fall and winter.

Effects of Flow on Fry, Juvenile, and Smolt Life Stages from February through June

Reclamation is storing water, delivering stored water and diverting inflow during this period. Water delivery for Klamath Project purposes includes delivery of water from Upper Klamath Lake storage and diversion of water from net inflows into Upper Klamath Lake. The delivery of water from Upper Klamath Lake storage does not adversely affect “without Reclamation” conditions on the Klamath River below Iron

Gate Dam. Thus, any adverse effects in the following analysis are attributable to diversion of water from net inflows only. Also, conclusions based on the following analyses recognize the lack of data demonstrating relationships between changes in Klamath River flow and coho survival.

Minor decreases (less than 10 percent) in fry habitat occur "with Reclamation" compared to "without Reclamation" in all water years (Table 6-5 and Table 6-6). Habitat losses range from –0.1 percent in May 16-31 of below average years between Iron Gate Dam and Shasta River and June 1-15 of average and below average years between Shasta River and Scott River to –8.9 percent in March 16-31 of dry years. Coho fry would probably not be affected by decreased carrying capacity and displacement of fry into less suitable habitat as a result of these minor habitat losses which exist within model error. As a result, survival of salmon fry should not be affected.

Based on this analysis, the proposed action may affect, but not likely to adversely affect fry life stage or critical habitat for coho salmon in the Klamath River.

Table 6-5. Coho fry habitat (percent optimal habitat) in Klamath River between Iron Gate Dam and Shasta River confluence. "Without Reclamation" compared to "with Reclamation".

	Wet			Above Average			Average			Below Average			Dry		
Time Step	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change
February	92.3	91.9	-0.5	78.9	78.2	-0.9	92.6	92.1	-0.6	72.0	70.7	-1.8	44.4	43.9	-1.0
March 1-15	91.3	92.7	1.5	98.3	98.0	-0.3	83.5	82.0	-1.8	61.2	58.6	-4.3	47.1	45.8	-2.7
March 16-31	91.6	92.9	1.5	98.9	98.7	-0.3	83.7	82.2	-1.8	59.9	56.9	-5.0	47.4	46.8	-1.4
April 1-15	93.9	95.3	1.5	93.9	93.3	-0.6	78.1	76.1	-2.6	50.2	49.5	-1.4	44.1	44.2	0.3
April 16-30	94.2	95.7	1.6	94.1	93.6	-0.5	79.8	78.6	-1.5	48.6	47.7	-1.8	44.0	44.1	0.3
May 1-15	93.8	93.7	-0.2	79.7	79.5	-0.3	69.7	68.8	-1.2	47.4	47.4	0.0	44.6	44.6	0.0
May 16-31	83.3	82.8	-0.6	71.4	70.9	-0.7	54.5	54.4	-0.2	47.4	47.3	-0.1	45.0	45.0	0.0
June 1-15	65.5	65.5	0.0	56.9	56.9	0.0	47.0	47.0	0.0	47.4	47.4	0.0	44.6	44.6	0.0

Table 6-6 Coho fry habitat (percent optimal habitat) in Klamath River between Shasta River and Scott River confluences. "Without Reclamation" compared to "with Reclamation".

	Wet			Above Average			Average			Below Average			Dry		
Time Step	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change
February	90.4	89.8	-0.7	72.6	71.8	-1.1	89.6	88.6	-1.1	63.3	61.8	-2.4	24.9	22.9	-7.9
March 1-15	91.8	92.8	1.0	97.6	97.1	-0.5	77.7	75.8	-2.4	50.2	47.2	-6.0	29.4	27.1	-7.9
March 16 -31	92.3	93.2	1.0	99.0	98.6	-0.4	77.6	75.7	-2.4	48.7	45.3	-7.0	31.2	28.4	-8.9
April 1-15	95.2	96.1	1.0	90.3	89.5	-0.8	69.1	66.7	-3.5	34.8	33.9	-2.6	31.2	30.6	-1.7
April 16-30	95.4	96.4	1.0	90.2	89.5	-0.7	71.1	69.7	-1.9	32.7	31.3	-4.4	31.6	31.1	-1.6
May 1-15	90.1	89.9	-0.2	70.8	70.5	-0.3	57.8	57.0	-1.5	29.6	29.5	-0.3	23.5	23.5	0.0
May 16 - 31	76.0	75.3	-0.9	61.5	60.9	-1.0	40.6	40.5	-0.3	29.3	29.1	-0.8	24.0	24.0	0.0
June 1-15	54.1	54.1	0.0	44.4	44.3	0.0	27.3	27.2	-0.1	29.0	28.9	-0.1	22.6	22.6	0.0

Effects on Young-of-the-Year Juveniles from July through September

Bartholow (1995) reviewed available data on temperature effects on anadromous species in the Klamath River and found that the mainstem Klamath experiences elevated temperatures deleterious to salmonids for much of the summer and early fall period. As described by Campbell (1995), increased water temperatures and lower saturated oxygen concentrations typically occur in the Klamath River during summer months, the same time of year that the growth and respiration cycles of aquatic plants affect dissolved oxygen concentration. Thus, water temperatures and water quality in mainstem Klamath River contribute to unfavorable environmental conditions for juvenile salmon during the summer (late June-September).

River flow can directly impact water temperatures in the Klamath River (Deas 2000). Flow and temperature simulations using the RMA-11 model in the sixty-mile reach from Iron Gate Dam to Seiad Valley suggest that during summer periods lower flows, as explained below, generally lead to slightly higher downstream temperatures (Table 6-7). Simulated temperature response for a typical mid-summer day at various Iron Gate Dam flows illustrates the flow-temperature interdependence. At 500 cfs, simulated daily mean water temperature increases 2.5 ^{o}C (4.9 ^{o}F) over the 60-mile reach from Iron Gate Dam to Seiad Valley, while at 3,000 cfs the simulated increase is roughly 0.9 ^{o}C (1.6 ^{o}F) (Table 6-7) (Deas 2000; Deas and Orlob 1999). Water temperatures are elevated at low flow rates because of an increase in transit time, less thermal mass allowing greater heating during the day, and shallower river conditions. At 500 cfs, a mean simulated temperature of approximately 25 ^{o}C (77 °F) was recorded at Seiad Valley, compared to about 23 ^{o}C (73.4 °F) at 3,000 cfs in mid-August (Deas 2000; Deas and Orlob 1999). Thus, high water temperatures can occur at high and low flows, depending on climatic conditions. The extent to which operations affect water temperature is complex and remains unclear (Hecht and Kamman 1996).

The NRC (2002) did not find any scientific support for proposed minimum Iron Gate Dam flows as a means of enhancing the maintenance and recovery of the coho salmon population in the reasonable and prudent alternative issued in NMFS's (2001) BO. The NRC (2002) suggested that higher flows from July through September may actually harm coho salmon if the source is warmer than the receiving water. The NRC (2002) strongly encouraged that additional rigorous studies be conducted to address this issue. Also, increased flows may have a detrimental effect on the availability of thermal refugia created by groundwater seepage and small tributary flows (NRC 2002). Increased flows may reduce the size of these refugia by causing more effective mixing of small amounts of locally derived cool water with much larger amounts of warm water from upstream (NRC 2002). The NRC (2002) also noted, however, that progressive depletion of flows in the Klamath River mainstem would at some point be detrimental to coho salmon through stranding or predation losses. They concluded that there is no scientific justification at present for deviating from flows derived from operational practices in place for the period 1990 – 1999 (NRC 2002).

Young-of-the-year survival, growth, and recruitment depend on the availability of total habitat, including suitable macrohabitat (water quality and temperature) and suitable microhabitat (depth, velocity, and cover) conditions under different river flows. There is a lack of data demonstrating a clear association between changes in Klamath River flow and habitat and the status of the salmon. The availability of suitable microhabitat may not be a primary factor in the survival of young-of-the-year salmonids when acute water temperatures prevail. Chronic (>15 ^{o}C or 59 ° F) and acute (>20 ^{o}C or 68 °F) water temperatures for salmonids in the Klamath River are based on an evaluation of existing published information on observed relationships between water temperature and Chinook salmon tolerances (Bartholow 1995). These "thresholds" may create a population bottleneck by impacting young-of-the-year and juvenile coho in late July and August. The fact that juvenile salmonids persist in the Klamath River mainstem despite temperatures that generally exceed these chronic and acute temperature thresholds (Yurok Tribal Fisheries Program 1999, 2000) illustrates the complexity of this issue.

Temperature has direct effects on physical, chemical, and biological processes in most aquatic systems. High temperatures increase chemical reactions, metabolic rates, and decrease the solubility of gases such as oxygen, carbon dioxide and nitrogen (Deas 2000). Excessive water temperature can reduce productivity and increase mortality of aquatic organisms. Temperature affects fish physiology, specifically respiration, food intake, digestion, assimilation, and behavior.

Bartholow (1995) found no data supporting the contention that Klamath River salmonid stocks were more thermally tolerant than other west coast stocks. In fact, the small amount of information available indicates no difference (Bartholow 1995). However, there is evidence that juvenile Chinook and coho salmon and steelhead persist in the Klamath River mainstem despite temperatures that generally exceed the chronic and acute temperature thresholds (Belchik 2000). Studies by Konecki et al. (1995) of juvenile coho salmon near St. Helens, Washington, found juvenile coho could tolerate water temperatures exceeding 24 ^{o}C (75.2 ^{o}F) and in some cases were observed in streams with temperatures as high as 29 ^{o}C (84.2 ^{o}F).

Klamath River flows greater than those resulting from the Rogue River basin proposed action downstream from Iron Gate Dam from July through September will not likely reduce mean water temperature to levels below chronic and acute levels for salmonids (Table 6-7). Deas and Orlob (1999) reported that higher flows from Iron Gate Dam in August resulted in water temperatures being reduced slightly (Table 6-7), but not reduced below the chronic or acute levels typical of summer conditions. The temperature of water released from Iron Gate Dam and temperature records at Seiad from late June through early September in many water year types approach or exceed acute thermal thresholds and may be a contributing factor to fish kills in the mainstem. Although fish do survive these temperatures, the complex relationship between summer/fall mainstem river flows and water temperatures, and their effects on the fishery in the Klamath River, limits Reclamation's ability to assess the Federal effects.

Table 6-7. Simulated effects of river flow on water temperatures in the Iron Gate Dam (RM 190) to Seiad Valley (RM 130) reach of the Klamath River for a typical mid-summer day

Simulated Iron Gate Dam flow (cfs)	Maximum diurnal temperature range in °C and (° F)	Simulated net temperature increase in the Iron Gate Dam to Seiad Valley reach in °C and (°F)	Travel time between Iron Gate Dam and Seiad Valley (days)	Mean temperature at Seiad Valley in °C and (°F)
500		2.5 (4.5)	2.5	25.0 (77.0)
1000	20-26 (68-79) @ RM 175	2.1 (3.8)	2.0	24.3 (75.7)
2000		1.3 (2.3)	1.5	23.5 (74.3)
3000	21-24 (70-75) @ RM 165	0.9 (1.6)	1.25	23.0 (73.4)

Source: Deas and Orlob 1999

Diurnal water temperatures, including maximum and minimum values, are also affected by flow regime. For low flows, daily maximum temperatures are higher and daily minimum water temperatures are lower, while at higher flows water temperature daily maximums are lower and minimum temperatures higher (Table 6-7). These diurnal fluctuations are for the "node of maximum fluctuation" (approximately a half day's travel distance) and are not characteristic of the entire mainstem Klamath River. This phenomenon dampens with distance downstream from Iron Gate Dam. Only recently, since the early 1990s, have affordable instantaneous temperature measuring devices been available. Thus, field studies on diurnal temperature effects on fish have not been done. In the absence of information on diurnal temperature effects, temperature acclimation studies provide some indication of effects of temperature changes on fish. Armour (1991) reported on studies of the acclimation effects in juvenile Chinook salmon which found fish subjected to higher initial water temperature could sustain higher maximum temperature than those acclimated to cold water. The data suggested that, even if fish are acclimated to 20 °C (68 °F), 50 percent mortalities can be expected if temperatures reach 25.1 °C (77 °F) during the day.

Reclamation recognizes that tributaries can play a crucial role in creating local thermal refugia for juvenile coho salmon during the summer in the Klamath River. Belchik (1997) studied salmonid use of cool water areas in the Klamath River between Iron Gate Dam and Seiad Creek during July and August 1996, an above average water year. He found that there was a significant relationship between numbers of juvenile salmonids and proximity of nearest cool water areas in Klamath River mainstem. He indicated that cool water areas provide key habitat for over-summering juvenile salmonids. Most cool water areas were located at mouths of tributaries (Belchik 1997).

Reclamation's Rogue River basin "with Reclamation" would result in minor flow decreases in the Klamath River as a result of diverting Jenny Creek flows to the Rogue River basin compared to "without Reclamation" from July through September (Figure 6-1 through Figure 6-10). However, based on temperature modeling, these low flow depletions would not likely affect water temperature appreciably. Table 6-7 suggests additional flow releases from Iron Gate Dam "without Reclamation" would not be expected to cool the mainstem river below the chronic temperature threshold of 15 °C (59 °F) for coho salmon during this period. Juvenile coho salmon in Klamath River from July through September are likely to encounter marginal to lethal water quality conditions regardless of the proposed action (Table 6-7 and Figure 6-1 through Figure 6-10). Daily average and maximum water temperatures are quite high, and the diurnal variation of temperatures may be stressful to fish.

The Klamath River has likely always been a relatively warm river system. Insolation and ambient air temperatures are primary factors affecting water temperatures in most rivers, including the Klamath. These climatic factors are completely independent and are not affected by Project operations. These factors influence water temperatures as distance increases downstream from Iron Gate Dam (Hecht and Kamman 1996;

Hanna 1997). Currently-depressed salmonid populations combined with successful introduction of numerous warm water fish species into the reservoir system suggests that natural climatic factors combined with major landscape alterations in the Klamath River watershed and its tributaries have caused higher water temperatures, thus favoring fish species other than salmonids.

Based on this analysis, the proposed action may affect, but not likely to adversely affect juvenile life stage or critical habitat for coho salmon in the Klamath River during this time period.

Effects of Flow on Adult Migration and Spawning from October through February

Reclamation stores water in Upper Klamath Lake and other Klamath Project reservoirs year-round, with a significant portion of the water being stored during October through March. In some years, storing water is significant in April, May, and June. The following analysis only considers the effects of storing water from October through February.

Adult coho salmon migrate into the Klamath River between September and January. The requirements of adult coho salmon during this time include a migratory corridor with suitable water depth and velocities, resting pools, and adequate water quality conditions (NMFS 2001). Successful immigration also depends on adequate fish passage conditions in the mainstem river and access to tributaries. Minimum Iron Gate Dam releases (September through January) under “with Reclamation” would vary slightly from “without Reclamation” conditions (Figure 6-1 through Figure 6-10). These small increments in flow changes related to the proposed action should not affect coho salmon migrations. Physical habitat modeling specific to adult coho salmon in the Klamath River has not occurred (NMFS 2001). Draft Hardy and Addley (2001) model results for Chinook salmon indicate spawning habitat is optimal at a flow of approximately 1,300 cfs in the Iron Gate Dam to Shasta River reach (NMFS 2001). Although it is reasonable to expect coho salmon to migrate successfully given this discharge and downstream flow accretions, this flow may not occur even under “without Reclamation” conditions in drier water years (Figure 6-4 and Figure 6-5). Also, tributary access would likely be affected by low flow with or without the proposed action in drier water years and would not be the sole result of the proposed action.

Available information indicates, in general, that water temperatures decrease in the Klamath River in October. By mid-October, temperatures measured at Iron Gate

Dam and at Seiad typically drop below 15 °C (59 °F) and are within the temperature range associated with normal coho salmon migration 7.2 °C – 15.5 °C (45-60 °F). By mid-December, temperatures typically decrease below 7.2 °C (45 °F) in these locations (NMFS 2001).

Passage conditions from the mainstem Klamath River into some tributaries have been a concern under relatively low flow conditions (Vogel and Marine 1994), particularly in dry years. Not only is access to the tributaries affected by mainstem passage conditions, but also by streambed and channel configurations and tributary flows. For example, substantial aggradation of large cobble and boulder material at the mouth of the Scott River creates a very shallow berm at low river flows that fish first entering this river must cross.

During drier years, low tributary flow may restrict passage independent of mainstem flows. The potential adverse effects to mainstem passage conditions and tributary access may result in spawning migration delays or straying due to natal stream inaccessibility. Because adult salmon do not feed during their freshwater spawning migration, individuals have a finite amount of energy reserves. Increased pre-spawning mortality and decreased spawning success may result under both "with Reclamation" and "without Reclamation"conditions in dry water years, as fish hold in the mainstem.

Although coho salmon have been observed spawning in the mainstem Klamath River (Reclamation 1998), it appears to be limited. Coho salmon spawning typically occurs during December and January in the Klamath River basin (Federal Register 60:38011). Klamath River water temperatures during the spawning period are typically within the acceptable range associated with coho salmon spawning in California 5.5 °C – 13.3 °C (42-56 °F) (Sandercock 1991).

Results of the spawning habitat analysis are summarized in Table 6-8 and Table 6-9. Examination of Table 6-8 shows that flows resulting from the proposed action generally slightly improve spawning habitat conditions compared to the "without Reclamation". Habitat increases occur during all water years in the October through February period except in dry years. The highest gain occurs in February of an average water year (+3 percent) between Iron Gate Dam and Shasta River. The greatest habitat loss occurs in February of dry water years (2.3 percent decrease) between Iron Gate Dam and Shasta River. Only minor spawning habitat gains would occur as a result of the "with Reclamation" in the Shasta River to Scott River reach of the Klamath River (Table 6-9).

Table 6-8. Chinook spawning habitat (percent optimal habitat) in the Klamath River between Iron Gate Dam and Shasta River confluence. "Without Reclamation" compared to "with Reclamation".

	Wet			Above Average			Average			Below Average			Dry		
Time Step	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change
October	54.0	54.6	1.1	76.6	77.1	0.6	87.6	88.1	0.5	100.0	100.0	0.0	89.9	89.9	0.0
November	71.0	71.2	0.3	93.1	93.3	0.1	93.7	93.9	0.2	94.6	94.9	0.3	92.7	92.5	-0.1
December	66.8	67.4	0.8	91.1	91.4	0.4	68.1	68.6	0.7	87.5	87.8	0.3	89.6	89.7	0.1
January	68.8	69.8	1.4	70.3	71.0	1.0	44.0	44.8	1.7	72.1	72.9	1.1	99.9	99.9	0.0
February	37.9	38.8	2.5	60.5	61.7	2.0	37.3	38.4	3.0	71.7	73.7	2.9	97.3	95.1	-2.3

Table 6-9. Chinook spawning habitat (percent optimal habitat) in the Klamath River between Shasta River and Scott River confluences; "Without Reclamation" compared to "with Reclamation".

	Wet			Above Average			Average			Below Average			Dry		
Time Step	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change	"Without Reclamation"	"With Reclamation"	Percent change
October	54.6	54.8	0.4	63.0	63.2	0.3	69.1	69.4	0.4	89.4	89.5	0.1	91.8	91.8	0.0
November	59.6	59.7	0.2	72.4	72.5	0.1	73.0	73.2	0.2	73.6	73.8	0.3	90.6	90.6	0.0
December	57.2	57.3	0.3	69.7	70.0	0.4	57.4	57.5	0.3	67.3	67.5	0.3	69.3	69.4	0.1
January	57.7	58.1	0.7	57.9	58.2	0.5	49.9	50.1	0.4	58.4	58.8	0.6	85.2	85.4	0.2
February	47.6	47.9	0.6	55.1	55.4	0.6	47.9	48.3	0.9	59.7	60.6	1.5	93.9	96.4	2.7

There is the potential effect during the spawning/egg incubation period of dewatering of incubating eggs if flows decline. Under "with Reclamation" and "without Reclamation" conditions flows generally decline between January and March in dry water years (Figure 6-5 and Figure 6-10). Thus, lower flow resulting from the "with Reclamation" and "without Reclamation" between January and March may result in some dewatering of incubating eggs in the mainstem Klamath River. However, the potential for this effect is small because of the small incremental change in flows would result in water depth changes that would not likely be detectable from "without Reclamation" flow changes.

Coho salmon eggs incubate for about 38-48 days in gravel redds following successful spawning, and fry emerge from the gravel about 2-3 weeks after hatching (Sandercock 1991). The survival of salmon eggs and alevins is dependent, in part, on stream and streambed conditions. For example, high winter flows and resulting gravel movement can result in heavy losses (Sandercock 1991). Flows released at Iron Gate Dam and downstream accretions are variable during this period both with and without the proposed action. Water temperatures measured at Seiad are typically similar to those at Iron Gate Dam during this period and within the preferred range for incubating salmonids.

Based on this analysis, the proposed action may affect, but not likely to adversely affect spawning/incubation life stages or critical habitat for coho salmon in the Klamath River during this time period.

6.2.3 Summary of Effects

Table 6-10 summarizes effects of the proposed action on SONCC coho salmon in the Rogue River and Klamath River basins. Table 6-12 uses the NMFS habitat matrix to summarize habitat features where we had sufficient data and notes the effects of the proposed action on coho salmon critical habitat.

In general, Reclamation's proposed action degrades summer temperatures, fish passage, and baseline hydrology in the Little Butte Creek and Bear Creek watersheds.

Overall, Reclamation's proposed action is likely to adversely affect most life stages of SONCC coho salmon in the Rogue River basin. In the Klamath River basin, the Project may affect, but is not likely to adversely affect most life stages of SONCC coho salmon. There is no effect on the remainder of the life stages.

Table 6-10. Summary of Effects on SONCC Coho Salmon and Critical Habitat ("with Reclamation" compared to "without Reclamation")

Stream Segment	Fry, Juvenile, Smolt (February - June)	Juveniles (July - September)	Adult Migration and Spawning (October - February)
Rogue River basin			
S. F. Little Butte Creek	Potential negative effect from low flows February – June. MA/LAA	Generally moderate-minor flow decreases; water operations are likely to affect water temperatures in some stream reaches. MA/LAA	Generally lower Proposed action flows may affect adult coho migrations in dry years, particularly in October. MA/LAA
Little Butte Creek	Potential negative effect from low flows in May of dry years. MA/LAA	Major flow increases in average and wet years; no change in dry years; water temperatures should be unaffected by operations. NE	Generally higher Proposed action flows is not likely to adversely affect coho salmon. MA/NLAA
Antelope Creek	Potential negative effects from low flows resulting from water diversion. MA/LAA	No summer diversions; water temperatures should be unaffected by operations. NE	Antelope Creek Diversion Dam may affect adult coho migrations with 1-cfs minimum flow. MA/LAA

Stream Segment	Fry, Juvenile, Smolt (February - June)	Juveniles (July - September)	Adult Migration and Spawning (October - February)
Emigrant Creek	Rapid down-ramping at Emigrant Dam may strand small fish; negative effects from zero flows February – June in dry years. MA/LAA	Wide flow fluctuations from storage releases at Emigrant Dam likely adversely affect fish habitat, including stranding of juveniles and preventing establishment of aquatic macroinvertebrates. MA/LAA	Zero flow during average and dry Octobers – February adversely affects potential adult coho migrations. MA/LAA
Bear Creek	Potential negative effects from low flows in average and dry years February – June. Potential adverse effects from not meeting fish passage criteria where canals cross tributaries. No fish passage provisions in Phoenix Canal may adversely affect smolts and jueniles. MA/LAA	Operations increase flows in most of Bear Creek; water withdrawal from tributaries may have negative (streamflow depletions) and positive effects (increased flows from irrigation water conveyance) on water temperature and fish habitat. Potential adverse effects from not meeting fish passage criteria where canals cross tributaries. No fish passage provisions in Phoenix Canal may adversely affect juveniles during irrigation season. MA/LAA	Major flow decreases in January and February may adversely affect adult fish passage into tributaries. Potential adverse effects from not meeting fish passage criteria where canals cross tributaries. MA/LAA
Klamath River basin			
Klamath River (Iron Gate Dam – Shasta River)	Minor decreases in fry habitat should not adversely affect coho survival. NE	Minor flow decreases not likely to adversely affect water temperature. MA/NLAA	Minor spawning habitat changes (gains and losses) should not adversely affect coho salmon. MA/NLAA
Klamath River (Shasta River – Scott River)	Minor decreases in fry habitat should not adversely affect coho survival. NE	Minor flow decreases not likely to adversely affect water temperature. MA/NLAA	Only minor spawning habitat gains with proposed action should not adversely affect coho salmon. NE

Table 6-11. NMFS matrix checklist documenting environmental baseline and general effects of Reclamation's operations on SONCC coho salmon critical habitat

Pathways	Environmental Baseline			Effects Of Actions		
Indicators	**Properly Functioning**	**At Risk**	**Not Properly Functioning**	**Restore**	**Maintain**	**Degrade**
Water Quality						
Temperature		X				X
Sediment/Turbidity		X			X	
Chemical Contaminants/ Nutrients		X			X	
Habitat Access						
Physical barriers		X				X
Habitat Elements						
Substrate	UNK			UNK		
Large woody debris		X			X	
Pool Frequency	UNK			UNK		
Pool Quality	UNK	X		UNK		
Off-channel Habitat	N/A			N/A		
Refugia	UNK	X		UNK		
Channel Conditions and Dynamics						
Width/Depth ratio	UNK			UNK		
Streambank condition		X			X	
Floodplain connectivity		X			X	
Flow/Hydrology						
Change in Peak/Base Flows	X					X
Increase in Drainage Network	N/A			N/A		
Watershed Conditions						
Road density and location	X				X	
Disturbance history		X			X	
Riparian Reserves	UNK			UNK		
UNK = unknownN/A = not applicable						

6.3 Lost River and Shortnose Suckers

6.3.1 Effects of Transbasin Water Diversion in Jenny Creek

Annual computed transbasin diversion from Jenny Creek ranged from 0 to 42,342 acre-feet between 1961 and 2001 and averaged 24,230 acre-feet. ODWR 50 percent exceedence runoff for Jenny Creek at the mouth is 51,198 acre-feet (estimated unimpaired flow) during the water years 1958-1987 (Cooper 2000). Water years 1958 to 1987 were selected as a base period due to the availability of data and the period's representation of the long-term average conditions. The average annual transbasin diversion for this time period was 23,178 acre-feet which represents 47 percent of the 50 percent exceedence runoff.

The seasonal pattern of natural runoff based on ODWR's 50-percent exceedance flows show 66 percent of the annual water year runoff occurs from March through May. These monthly flows range from 5,737 acre-feet in May to 14,757 acre-feet in April. Exceedance flows from June through September comprise 6.5 percent of the annual water year runoff ranging from 464 acre-feet in September to 1,529 acre-feet in June.

Suckers don't occupy Jenny Creek above the waterfalls; therefore, there are no direct effects on endangered suckers.

The lower 2 miles of Jenny Creek downstream from the waterfalls are proposed critical habitat for endangered suckers. The proposed action results in flow reductions and some unquantified reduction in potential sucker spawning habitat. The proposed action has little effect on water quality because most inflow from Jenny Creek occurs during the spring when Iron Gate Reservoir water quality is good and inflow from Klamath River is high. During the summer when water quality in Iron Gate Reservoir is poor, Jenny Creek inflows are very low and have a negligible effect on reservoir water.

6.3.2 Effects of Transbasin Water Diversion in Iron Gate Reservoir

The water level of Iron Gate Reservoir is unaffected by the transbasin diversion due to the small size of the reservoir and large volume of water received from the upper Klamath River basin.

Iron Gate Reservoir may provide habitat for a residual spawning population of suckers. The reservoir, however, doesn't support a viable population of suckers because of poor water quality during summer months, lack of larval and juvenile shoreline habitat, lack of spawning habitat, dominance of exotic predatory fish, and lack of fish passage facilities.

Summary of Effects

Reclamation determined the effects of ongoing operations may affect but are not likely to adversely affect Lost River and shortnose suckers. Further, Reclamation determined the proposed action is likely to adversely modify proposed critical habitat for endangered suckers in Jenny Creek. These determinations are made based on the following information:

Iron Gate Reservoir water level is unaffected by the transbasin diversion due to the small size of Iron Gate Reservoir and the large volume of water received from upper Klamath basin. Daily fluctuation related to power generation average 0.5 feet and the maximum fluctuation between minimum and full pool elevations is 8 feet (PacificCorp 2000).

Water quality has little effect from the operation of the proposed action because most inflow from Jenny Creek occurs during spring when Iron Gate Reservoir water quality is good and inflow from Klamath River is high.

Flow reduction in Jenny Creek may reduce potential sucker spawning habitat, thus affecting proposed critical habitat for sucker spawning during drier years.

6.4 Northern Spotted Owl

The greatest threat facing the northern spotted owl is the loss and fragmentation of habitat mainly through timber harvest and forest fires. The drought and accompanying severe fire seasons in recent years are threats to spotted owl recovery in the Pacific Northwest where fuels have accumulated over decades of fire suppression. These primary causes of spotted owl decline would have occurred even if Reclamation's Rogue River Basin Project had never been constructed. The harvest of trees, particularly the practices of clear-cutting and the high priority of harvesting the largest, oldest trees are more problematic to spotted owl conservation than any other identified threat. Secondarily, fire management policies, now recognized as detrimental to ecosystem health have led to more frequent and more destructive large-scale fires which have the same effect of eliminating and fragmenting spotted owl habitat.

Reclamation determined that there were five spotted owl activity centers located within one-mile of Reclamation facilities while analyzing the effects of operations on the northern spotted owl. Spotted owl activity centers are areas where a single owl or pair have a home range. All five of these activity center locations are in the Klamath River basin on BLM administered lands.

Typical spotted owl habitat is mid to high elevation mature forest where there are uneven-aged stands of conifers. Spotted owls do not seem to show any affinity towards nesting or maintaining home ranges near large bodies of water. Spotted owls are not attracted to reservoirs, dams, or canals for prey items because the small rodents that make up the spotted owl's diet are also easily found away from these structures. Water is supplied to irrigators primarily in low elevation lands in Bear Creek drainage where human populations are aggregated, and therefore, suitable spotted owl habitat does not exist.

The storage of water in high elevation reservoirs and canals occurs in areas of suitable spotted owl habitat. Hyatt Reservoir and Howard Prairie Lake and their associated dams and canals are located in the southern end of the Cascade Range in coniferous forest. Hyatt Reservoir has no spotted owl activity centers located within approximately one mile of its shoreline, while a total of five activity centers each within approximately one mile of a Reclamation facility have been identified near Howard Prairie Lake, Howard Prairie Canal, and Soda Creek Canal.

With respect to the operation and maintenance of the Howard Prairie and Soda Creek Canals, spotted owl habitat and prey are not affected by the presence of these water conveyance structures. The operation of Reclamation's reservoirs does not affect spotted owls directly, but the presence of these large water bodies does draw people to recreate on and around the reservoirs. Camping areas are at both lakes, although at Hyatt Reservoir campgrounds are less developed, more dispersed, and there are privately owned cabins. Howard Prairie Lake has more fee campgrounds and recreational facilities as well as dispersed camping on adjacent BLM land.

Summary of Effects

Based on the current identified threats to the northern spotted owl and the life history characteristics of this species, the proposed action does not affect northern spotted owls. However, recreational pursuits in the area of Howard Prairie Lake may have indirect effects on owl life functions. Recreational activities and management in the vicinity of spotted owl habitats are under BLM jurisdiction.

6.5 Bald Eagle

6.5.1 Analysis approach

The annual operation and maintenance of Reclamation dams and reservoirs may have an effect on both nesting and wintering bald eagles, primarily by affecting their primary prey base of fish and, to a lesser extent, waterfowl. Seasonal fluctuations in reservoir levels and alterations in stream flows below Reclamation dams may have direct effects on the quantity and quality of habitat of prey populations, therefore, may influence prey health and abundance. These operations may also affect the ability of bald eagles to exploit the available prey species, by making prey more or less vulnerable to predation.

In assessing the effects of continued operation and maintenance activities at Federal reservoirs it is important to recognize that the bald eagle population inhabiting these areas has been attracted to and has adapted, at least in part, to the conditions which have been and will continue to be present, such as fluctuating water levels which affect abundance and availability of prey. Indeed, the bald eagle population in the basin has been growing over the last 30 years in spite of changes in annual and seasonal operation scenarios dictated by differing hydrologic conditions.

The analysis approach assumes the presence of Federal reservoirs. The “without Reclamation” operations, described in this BA, are not applicable to this analysis because they eliminate Reclamation facilities. Since the growing eagle population has experienced and adapted to the existence of Federal reservoirs for the last 30 years, it is reasonable to establish the existence of reservoirs and use historic operations as the “without Reclamation” conditions by which to evaluate the effect of operations on the bald eagle population.

Howard Prairie Lake

The surface of Howard Prairie Lake seldom freezes over completely. Bald eagles are able to forage year-round and are usually observed at Howard Prairie Lake between breeding seasons, i.e. wintering. The ODFW stocks Howard Prairie Lake annually in May with over 300,000 hatchery fingerling rainbow trout. The stocking program provides a consistent prey base for the local eagle population.

The water level in Howard Prairie Lake fluctuates seasonally and varies due to hydrologic conditions. Prey fish species will be affected by reservoir operations and this may affect bald eagles. In wet years the reservoir may contain over 60,000 acre feet of water and during especially dry years it may be below 10,000 acre feet. Since bald eagles have been breeding at Howard Prairie Lake there have been both wet and dry years. From 1983 through 1999 there have been eight winters where storage in the reservoir peaked at over 60,000 acre feet, 4 years when the reservoir reached its highest storage level between 40,000 and 60,000 acre feet, and 4 years where storage was below 40,000 acre feet. During this 16-year period bald eagle breeding success has also fluctuated but there does not appear to be a discernable relationship between reservoir operations and breeding success (Figure 6-13).

The addition of new breeding territories has increased the potential number of chicks that could be fledged at Howard Prairie Lake; if all pairs are successful in the same year from 1-2 chicks annually (when there was one breeding territory) to 3-6 or more (with 3 territories now active). In the drier years occurring from 1988 to 1995 there was the establishment of the reservoir's second breeding territory and 2 successive years when 3 chicks fledged. Following those dry years there was another cycle of better years (1996-1999) and reproductive success was low overall. In 1999, Howard Prairie eagle pairs raised a total of 4 chicks, the most successful year to date. Howard Prairie operations do not appear to be adversely affecting bald eagles.

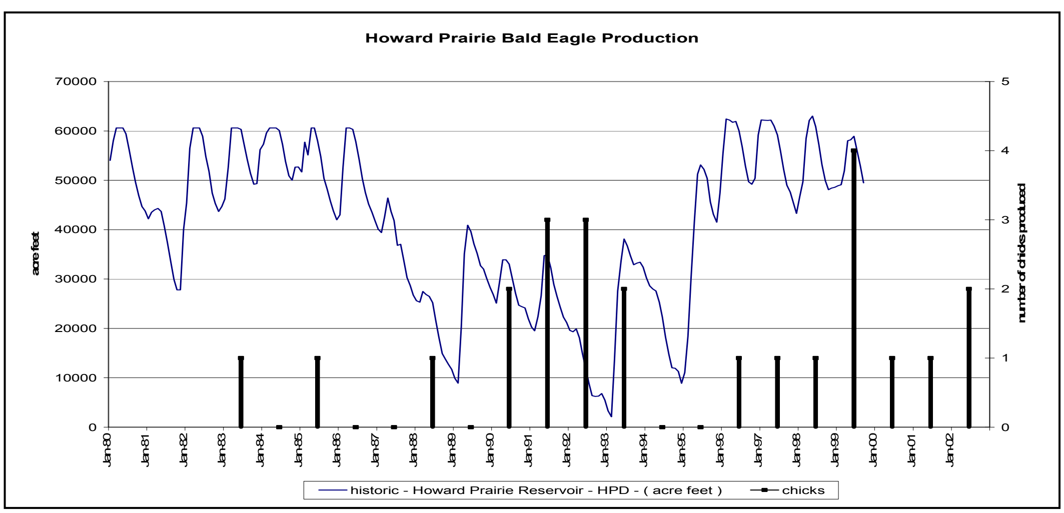

Figure 6-13. Bald eagle production at Howard Prairie Lake.

Hyatt Reservoir

Hyatt Reservoir has had one breeding territory since 1973 (perhaps longer) with no additional territories being established. One characteristic is its high density of osprey; often there are as many as 10 nesting pairs at the reservoir (Kaiser 2001). Competition for prey between eagles and osprey may be prohibiting new pairs from nesting at Hyatt Reservoir. Available fish prey include 250,000 fingerling and over 17,000 legal size rainbow trout supplied by ODFW fish hatcheries in April and May. The reservoir is not a known wintering site for eagles because the lake usually freezes over and eagles are seldom observed in the area outside the breeding season.

Since eagle nest monitoring began in Oregon in 1973 the Hyatt nest has produced 26 chicks (0.87 chicks/year). There have been 10 years during this period that the nest did not produce any chicks (Figure 6-14). Lake storage peaked at over 16,000 acre feet in some of those years. Other years when the nest failed to produce young the lake dropped to 500 acre feet (September 1994). In Hyatt Reservoir's driest year, when the lake was completely dry by August in 1992 the eagle pair was able to produce one eaglet. Hyatt Reservoir operations do not appear to have a negative affect on bald eagle reproduction.

Emigrant Lake

The bald eagles at Emigrant Lake prey on fish in the lake including 6,500 precocial winter steelhead and 7,000 legal size rainbow trout supplied by ODFW in March and April. It is likely that the nesting pair also winters in the vicinity of the lake since Emigrant Lake does not freeze in the winter.

When the eagles established a nest near Emigrant Lake in 1993, the previous winter the reservoir stored over 38,000 acre feet at it's peak storage. In 1994, the reservoir dropped to 1,000 acre feet in August. The following five years, from 1995 to 1999 reservoir storage fluctuated seasonally between approximately 15,000 and 38,000 acre feet and the eagle pair still did not successfully produce young. In 2000, the eagles moved to a new nest location downslope from the previous site and since then have produced one chick annually (2000-2001). It appears that the difference in elevation between the nest and the lake was likely the cause of nest failure, although other factors may also have contributed, reservoir operations do not seem to be associated with poor breeding success (Figure 6-15).

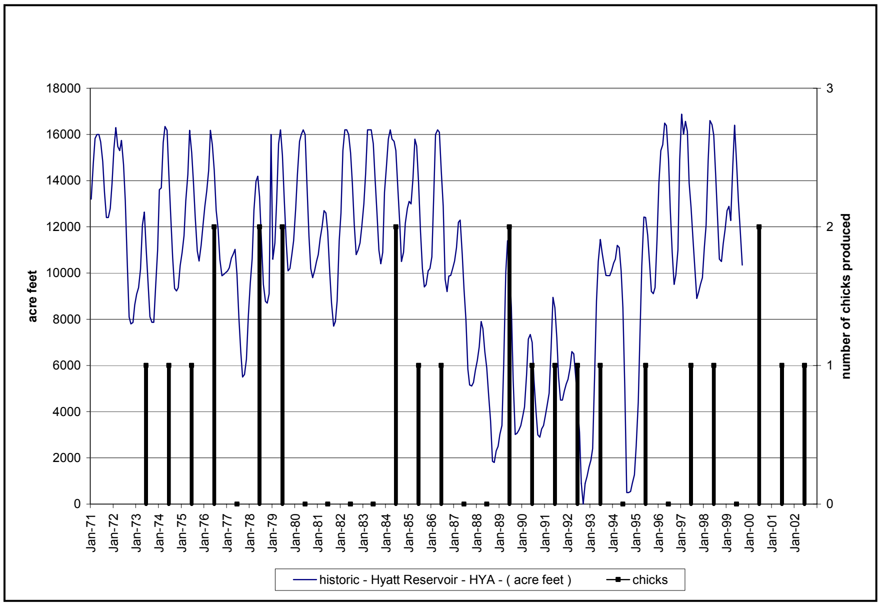

Figure 6-14. Bald eagle production at Hyatt Reservoir.

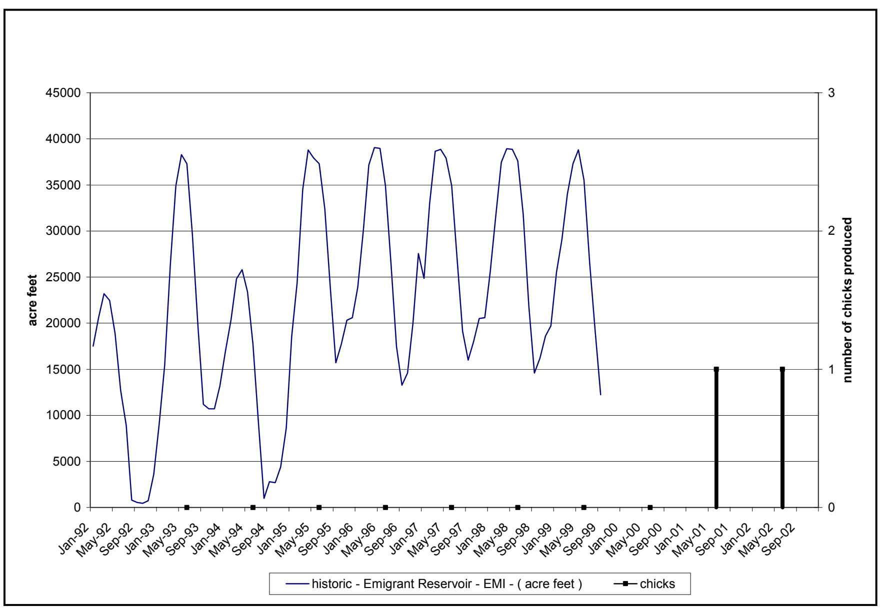

Figure 6-15. Bald eagle production at Emigrant Lake.

6.5.2 Effects of Transbasin Water Transfer on Bald Eagles in Klamath River Basin

The small transbasin water transfers of upper Klamath River basin inflow from Jenny Creek average about 24,230 acre-feet to the Rogue River basin.

Reclamation's Klamath Area Office consulted on the effects of Klamath Project operation on threatened bald eagles in 1992 and 2001 (Reclamation 1992 and 2001). USFWS determined in both the 1992 and 2001 biological opinions that the proposed Klamath Project operation is not likely to jeopardize the continued existence of the bald eagle (USFWS 1992 and 2001). However, USFWS indicated in 2001 the Klamath Project proposed action is likely to result in significant reduction or elimination of the prey base for the bald eagle due to curtailed water deliveries to areas containing important eagle feeding habitat. USFWS included Reasonable and Prudent Measures in the 2001 biological opinion to minimize impacts of the take.

Summary of Effects

Based on the analysis, bald eagle survival and fecundity do not appear to be negatively affected by the proposed action. Bald eagle populations are increasing statewide and in the local area. Large open bodies of water stocked with fish have provided forage for the eagles during annual breeding and wintering periods. The characteristic sensitivity of eagles to humans during their breeding season may be a concern if recreation is not planned and managed with this species in mind. Overall, the proposed action may affect, but is not likely to adversely affect bald eagles.

6.6 Gentner's Fritillary

Gentner's fritillary grow in forest openings within three habitats: oak woodlands dominated by Oregon white oak, mixed hardwood forests dominated by Pacific madrone, and coniferous forests dominated by Douglas fir.

Gentner's fritillary is threatened by disturbance, alteration, and loss of habitat. It does not appear to be an early colonizer of recently disturbed habitat, nor a late successional species found in old growth, closed canopy forests. This species prefers situations where it can receive at least partial light. It appears to have a moisture requirement in that it has not been found in fully exposed rocky, skeletal soil types (e.g., open grasslands), but prefers a level of soil moisture that is also capable of supporting trees and shrubs. Its relationship with disturbance is not clear, although the species exists in communities that had fairly frequent fire return intervals historically.

The nearest population center is one-half mile from the Phoenix Canal. Operations and maintenance will not impact plant populations or associated forested habitat. Therefore, the proposed action has no effect on Gentner's fritillary.

6.7 Vernal Pool Species

6.7.1 Factors Influencing the Hydrology of Vernal Pools

Although precipitation typically fills vernal pools, vernal pool hydrology can be influenced by a variety of factors. Ongoing operations may impact Agate Desert vernal pools by altering their hydrologic regime. Potential impacts to vernal pools and listed species habitat can be classified as follows where vernal pools occur on or adjacent to irrigated lands and the associated water distribution system (Patterson 2001):

- Conversion. Vernal pool habitat may occur within current Project land parcels which have only been partially converted to cultivated fields by ripping the duripan and leveling the soil. These areas may be subject to future conversion due to the availability of irrigation water.
- Direct Application. Vernal pool habitat may persist in areas of irrigated pasture where topographic alteration has not totally eliminated surface ponding. These pools may be subject to application of water in late spring and summer depending on individual irrigation practices. This could result in conversion to emergent aquatic plant species and loss of vernal pool species.
- Waste. Vernal pool habitat may occur adjacent to or downslope from Project lands and unused irrigation runoff may cause adverse effects. Dry-season irrigation runoff flowing into off-site vernal pools will increase populations of drought-intolerant wetland species and displace native vernal pools species.
- Impoundment. Temporary impoundment of water can result in increased water durations and depths in natural vernal pools where water delivery canals and distribution laterals interrupt surface runoff in vernal pool landscapes. Natural vernal pools normally have contributing watersheds of less than five times their surface area. Artificial structures such as berms adjacent to canals and laterals can result in diversion of large watersheds into individual pools.

The impacts considered in the analysis are for a worst-case scenario and are based on proximity of vernal pool complexes to irrigated lands or water conveyance facilities;

therefore actual impacts are likely to be less severe. Table 6-12 shows acres of potential impact to vernal pool habitat. The impact analysis was organized by irrigation district boundaries. The effects from the proposed action include areas only near Agate Lake and Hopkins Canal (interrelated and interdependent facilities). The Agate Lake Resource Management Plan provides more detail on areas immediately adjacent to Agate Lake (Reclamation 2000).

Table 6-12. Acres of Potential Impact to Vernal Pool Habitat by Impact Type and Irrigation District

	C/D	C/D/I	C/D/W	C/D/W/I	D	I	W	W/I	Total
MID	102.5		43.1			4.3	87.6	3.4	240.9
RRVID	408.6	10.8	21.6	0.7	8.9	8.8	99.4	17.3	576.1
Total	511.1	10.8	64.7	0.7	8.9	13.1	187	20.7	817
C = Conversion D = Direct Application I = Impoundment W = Waste Flow									

	Conversion	Direct Application	Waste	Impoundment
MID	145.6	145.6	91	7.7
RRVID	441.7	450.6	116.7	26.1
Total	587.3	596.2	207.7	33.8

Source: Patterson 2001

Figure 6-16 displays the spatial configuration of remaining vernal pool complexes, their relative habitat value based on a function and condition assessment (Borgias and Patterson 1999), and which vernal pool complexes may be affected. Seven criteria used in the function and condition assessment are:

- complex size
- average vernal pool abundance within each complex
- listed nonendemic species (vernal pool fairy shrimp)
- endemic plant species (large-flowered woolly meadowfoam, Cook's lomatium)
- probable historic ranges of vernal pool fairy shrimp, large-flowered wooly meadowfoam, and Cook's lomatium
- complex condition (native species diversity, habitat diversity, lack of physical disturbance, and lack of major nonnative species competition)
- defensibility of the complex (compatible land uses, watershed integrity, and lack of adverse edge effects

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ROGUE RIVER VALLEY IRRIGATION DISTRICT

MEDFORD IRRIGATION DISTRICT

U.S. BUREAU OF RECLAMATION

VERNAL POOL IMPACT ANALYSIS

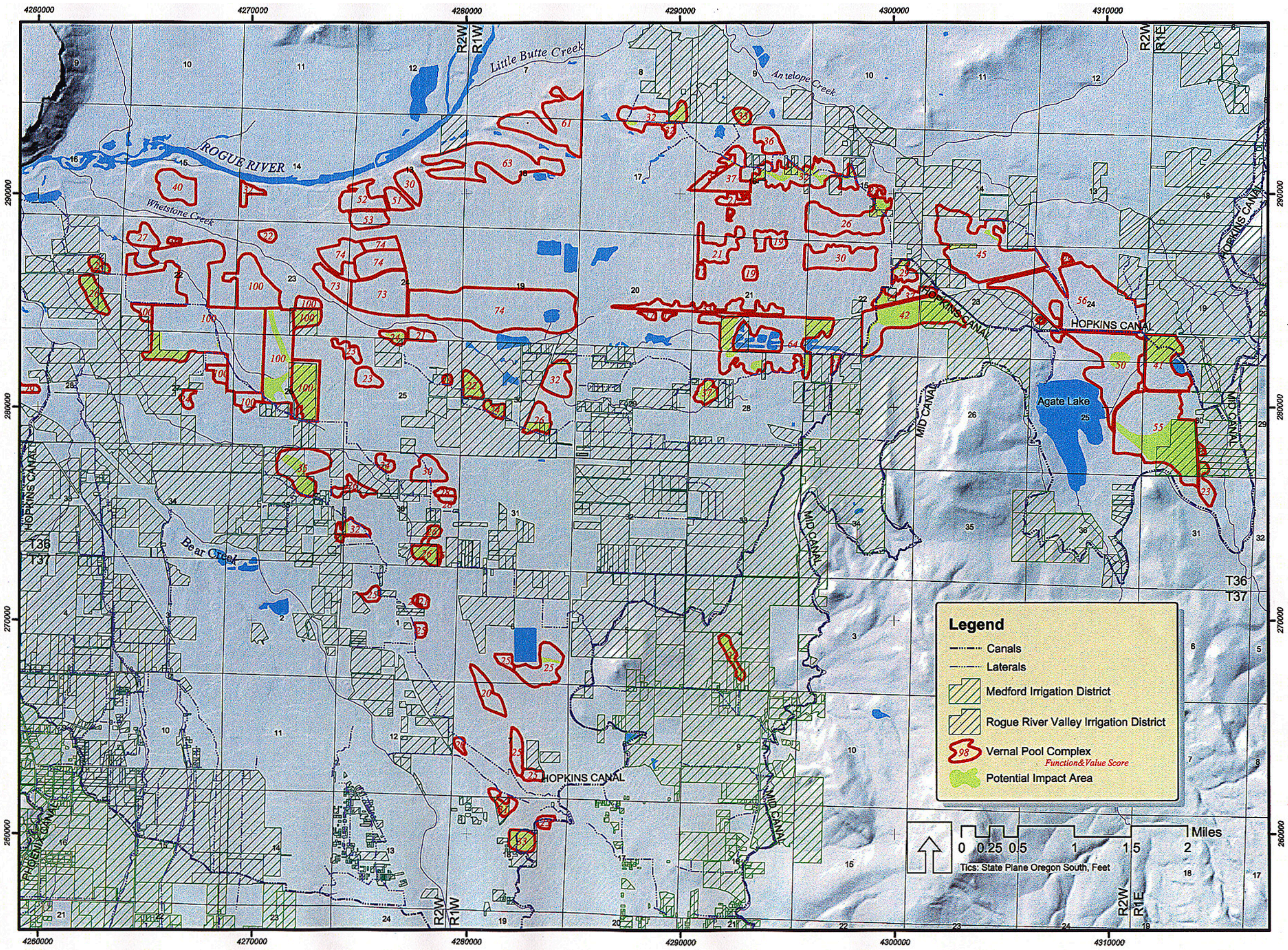

Figure 6-16

6.7.2 Large-Flowered Woolly Meadowfoam

Patterson (2001) estimated 817 acres of vernal pool complex habitat, all within the range of large-flowered woolly meadowfoam, may be potentially impacted by altered hydrology as a result of the Project (Table 6-12). Some 211.4 of the potentially impacted acres are in vernal pool complexes from which the species has been recorded (Table 6-13). All of these acres are lands within the boundaries of or are affected by RRVID. Some 605.6 of the potentially impacted acres are in vernal pool complexes within the known range but from which large-flowered woolly meadowfoam has not been recorded. Of these acres, 240.9 are lands within or potentially affected by MID and 364.7 are lands within or potentially affected by RRVID.

Table 6-13. Acres of Potential Impact to Large-flowered Woolly Meadowfoam by Irrigation District and Distribution Data

	Not Within Known Range	Within Known Range But Not Recorded From Complex Where Potential Impact Is Mapped	Recorded From Complex Where Potential Impact Is Mapped
MID	0	240.9	0
RRVID	0	364.7	211.4
Total	0	605.6	211.4

Source: Patterson 2001

Large-flowered woolly meadowfoam occupies 3,264 acres of vernal pool complex (Patterson 2001). Thus, approximately 6.5 percent (211.4/3,264) of the acreage in which this species occurs may be impacted.

Summary of Effects

Ongoing operations are likely to adversely affect some Agate Desert occurrences of large-flowered woolly meadowfoam by continuing to alter the hydrologic regime under which the vernal pools formed and the species evolved. Impacts are related to alterations of the natural hydrologic regime that sustains vernal pools. Approximately 211.4 acres of vernal pool complex from which the species has been recorded may be adversely affected by any or all of the following: conversion, direct application, wastewater runoff, and impoundment. This represents approximately 6.5 percent of the acreage of vernal pool complex which is occupied by the species. An additional, 394.2 acres within the known range but without species records may be similarly impacted. Surveys will likely be necessary to determine and confirm actual impacts of ongoing Federal operation and maintenance activities on remaining Agate Desert vernal pool habitats.

6.7.3 Cook's Lomatium

Of the 817 acres of vernal pool habitat that could be potentially impacted by altered hydrology from ongoing operations (Table 6-12), 616 of these acres are within the known range of Cook's lomatium (Table 6-14). Some 332.7 of the potentially impacted acres are in vernal pool complexes from which the species has been recorded. Of these, 94.3 acres are within the boundaries of or are potentially affected by MID and 238.4 acres are within the boundaries of or are potentially affected by RRVID. Some 283.3 of the potentially impacted acres are in vernal pool complexes within the known range in Agate Desert but from which Cook's lomatium has not been recorded. All of these acres are lands within the boundaries of or are potentially affected by RRVID.

Table 6-14. Acres of Potential Impact to Cook's Lomatium by Irrigation District and Distribution Data

	Not Within Known Range in Agate Desert	Within Known Range But Not Recorded From Complex Where Potential Impact Is Mapped	Recorded From Complex Where Potential Impact Is Mapped
MID	146.6	0	94.3
RRVID	54.4	283.3	238.4
Total	201	283.3	332.7

Source: Patterson 2001

Cook's lomatium occupies 2,167 acres of vernal pool complex in the Agate Desert (Patterson 2001). Thus, approximately 15 percent (332.7/2,167) of the vernal pool complex acreage in which this species occurs may potentially be impacted by ongoing operations.

Summary of Effects

Ongoing operations are likely to adversely affect some Agate Desert occurrences of Cook's lomatium by continuing to alter the hydrologic regime under which the vernal pools formed and species evolved. Impacts are related to alterations of the natural hydrologic regimes that sustain vernal pools in the Agate Desert. Approximately 333 acres of vernal pool complex from which the species has been recorded may potentially be affected by conversion, direct application, wastewater runoff, and impoundment. This represents approximately 15 percent of the vernal pool complex acreage occupied by Cook's lomatium. An additional 283 acres within the known range but without species records may be similarly impacted. Surveys will likely be necessary to determine and confirm actual impacts of ongoing Federal operation and maintenance activities on remaining Agate Desert vernal pool habitat occupied by this species.

6.7.4 Vernal Pool Fairy Shrimp

Patterson (2001) estimated 817 acres of vernal pool habitat, all within the known range within Agate Desert of vernal pool fairy shrimp, may be potentially impacted by altered hydrology (Table 6-12). Many potential impact areas are subject to more than one impact type. Some 491.5 of the potentially impacted acres are in vernal pool complexes from which vernal pool fairy shrimp have been recorded (Table 6-15). Of these, 218.8 acres are within the boundaries of or are potentially affected by MID and 272.7 acres are within the boundaries of or are potentially affected by RRVID. Some 325.5 of the potentially impacted acres are in vernal pool complexes from which the vernal pool fairy shrimp have not been recorded. Of these, 22.1 acres are within the boundaries of or are potentially affected by MID, and 303.4 acres are within the boundaries of or are potentially affected by RRVID.

Table 6-15. Acres of Potential Impact to Vernal Pool Fairy Shrimp

	Not Within Known Range	Within Known Range But Not Recorded From Complex Where Potential Impact Is Mapped	Recorded From Complex Where Potential Impact Is Mapped
MID	0	22.1	218.8
RRVID	0	303.4	272.7
Total	0	325.5	491.5

Source: Patterson 2001

Acres of occupied habitat potentially impacted by pesticide, fertilizer application, and runoff would be similar to acres potentially impacted by altered hydrology (817 acres).

Summary of Effects

Ongoing operations are likely to adversely affect some Agate Desert vernal pool fairy shrimp habitats by continuing to alter the hydrologic regime under which the vernal pools formed and vernal pool fairy shrimp evolved. Approximately 17 percent (817 acres of potential impact/4,700 acres of remaining vernal pool complex habitat) of the remaining vernal pool acreage in Agate Desert may potentially be adversely affected by any or all of the following: conversion, direct application, wastewater runoff, and impoundment. This potential impact acreage represents approximately 4 percent (817 acres of the 21,000 acres of vernal pool complex habitat historically present) of the historic extent of vernal pool habitat in Agate Desert. Surveys will likely be necessary to determine and confirm actual impacts of ongoing Federal operation and maintenance activities on remaining Agate Desert vernal pool habitats.